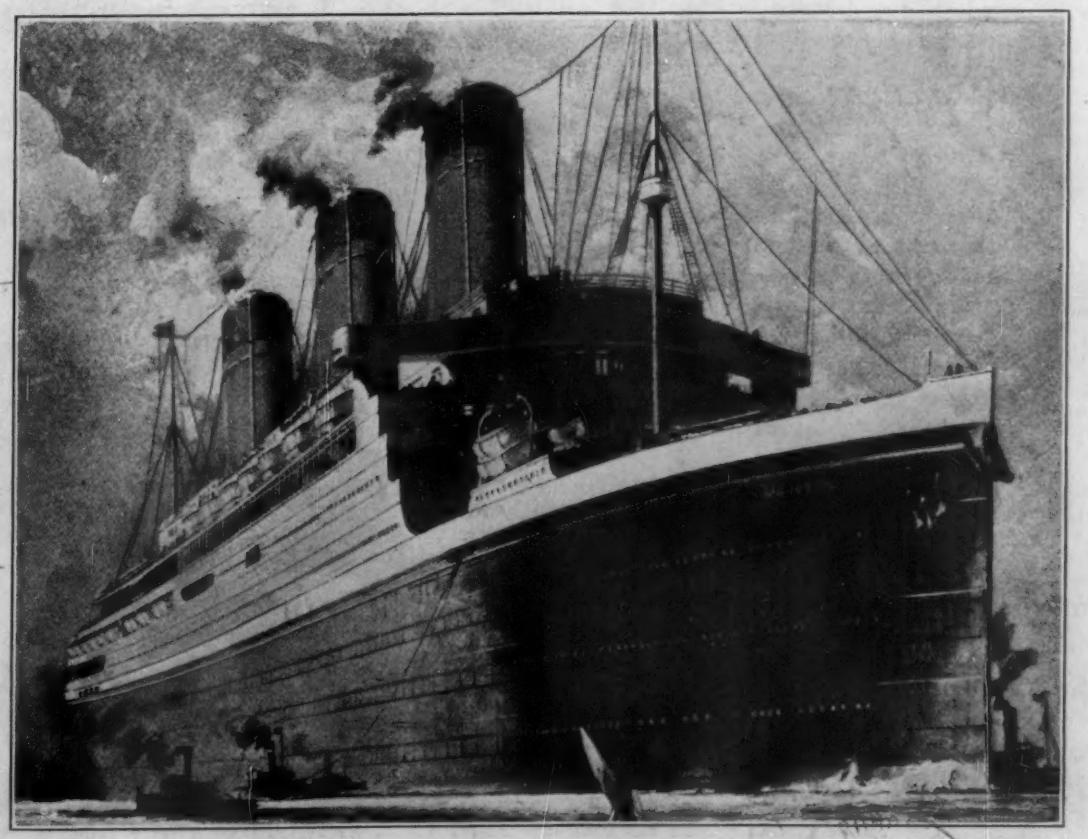
THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

VOL. VII, NO. 3 MAY, 1926



THE S. S. MAJESTIC

LIBRARY OF MAY 26 PERIODICAL DIVISION

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

When a bearing goes bad— Lead comes to the rescue

LEAD is a quiet, serious-minded metal which goes about its business without the aid of a press agent and a battery of cheer leaders.

And lead's business is to take an essential part in practically every modern industry. Most often it is the guardian, protecting the weather-beaten structures of buildings, sheathing the wires that carry power and light to every home, every factory.

Production of an entire plant may be seriously interrupted when one bearing on a single machine goes bad. What is the remedy? Lead. Not lead alone—it is perfectly willing to work with other metals to form babbitt alloys that are stronger, more durable, more dependable than any leadless bearing metal.

"But," says the babbitt user, "which of the dozens of different grades of lead alloys will serve my purpose and save my plant from all the expense of a breakdown?"

Eagle Babbitt Service gives him the answer. For Eagle-Picher research has produced three different grades of bearing metal which are designed scientifically to fill 95% of all babbitt requirements. They are known as Eagle Dreadnaught *High-Speed*, Eagle Outlasta *General Service*, and Eagle Standard No. 4. And Eagle Babbitt Service stands ready to supply special alloys to fill the special needs which industry may develop.

This babbitt service is only one phase of productive research in the Eagle-Picher institution which is constantly on the watch for new uses for lead in all its useful forms. Tomorrow, when industry's developing processes require new services from lead, Eagle-Picher will be ready to supply the need.

The EAGLE-PICHER LEAD COMPANY · 134 *North La Salle Street* · *Chicago*

EAGLE-PICHER

[Producers of Lead and Allied Products]

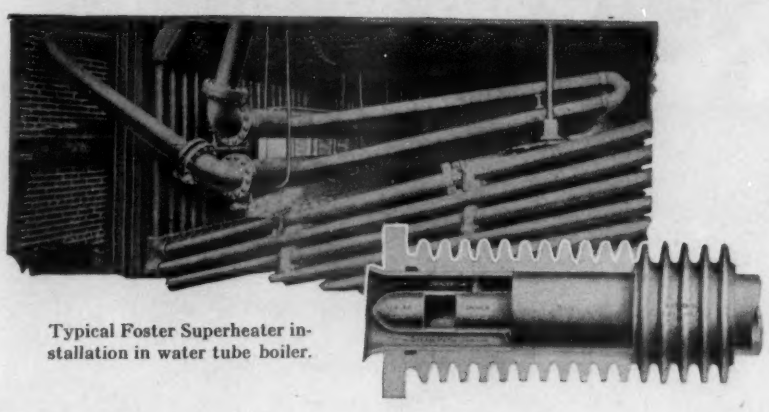
Sales Offices

CINCINNATI CLEVELAND PITTSBURGH PHILADELPHIA NEW YORK MINNEAPOLIS
BOSTON BUFFALO DETROIT BALTIMORE NEW ORLEANS KANSAS CITY ST. LOUIS JOPLIN

Manufacturing Plants

CINCINNATI NEWARK, N. J. GALENA, KAS. HENRYETTA, OKLA. PICHER, OKLA. CHICAGO
EAST ST. LOUIS, ILL. ARGO, ILL. JOPLIN, MO. HILLSBORO, ILL. ONTARIO OKLA.

Reducing power costs in every industry



Typical Foster Superheater installation in water tube boiler.

For better power plant economy

The fact that superheated steam will save from 5 to 20 per cent in terms of fuel used has been largely established through the operating records of the 10,000 Foster Superheater installations extending over 20 years of service.

The patented Foster construction promotes power plant economy in other ways as well. It protects piping, fittings, and engine parts from the expansion and contraction strains of a variable steam temperature. The temperature fluctuations that would otherwise result from variations in steam demand or furnace conditions are absorbed by the distinctive Foster Extended Surface.

Write for the Foster Superheater Book, describing the Foster Superheater construction and records.

POWER SPECIALTY COMPANY

Foster Superheaters and Economizers

111 Broadway, NEW YORK

Boston Philadelphia Pittsburgh Chicago San Francisco
Kansas City Detroit Dallas Denver London, England
Plants at Dansville, N. Y., and Egham, England

A few users of Foster Superheaters

Paper	West Virginia Pulp & Paper Co.
Copper	Phelps Dodge Company
Zinc	New Jersey Zinc Co.
Aluminum	Aluminum Co. of America
Lead	National Lead Co.
Steel	U. S. Steel Corp.
Nickel	International Nickel Co.
Gold	Homestake Mining Co.
Coal	Consolidated Coal Co.
Coke	Semet Solvay Co.
Oil	Standard Oil Co.
Cement	Alpha Portland Cement Co.
Harvesters	International Harvester Co.
Plows	Oliver Chilled Plow Co.
Fertilizer	American Agricul. Chem. Co.
Automobiles	Packard Motor Car Co.
Tires	Firestone Tire & Rubber Co.
Electrical Apparatus	Western Electric Co.
Explosives	E. I. du Pont de Nemours Co.
Firearms	Winchester Repeat. Arms Co.
Meat Packers	Swift & Co.
Milk Products	Borden's Cond. Milk Co.
Biscuits	National Biscuit Co.
Chocolate	Hershey Chocolate Co.
Ice	American Ice Co.
Cottons	Riverside & Dan Riv. Mills
Woolens	American Woolen Mills
Shoes	Endicott Johnson Co.
Leather	Pfister & Vogel Leather Co.
Chemicals	General Chemical Co.
Paints	Sherwin-Williams Co.
Soap	N. K. Fairbanks Co.
Locomotives	American Locomotive Co.
Cars	American Car & Foundry Co.
Cash Registers	National Cash Register Co.
Talking Machines	Victor Talking Mach. Co.
Pianos	Aeolian Co.
Cameras	Eastman Kodak Co.
Clocks	Western Clock Co.
Publishers	Curtis Publishing Co.
Mail Orders	Sears, Roebuck & Co.

Why they use Foster Superheaters

1. A steel tube for strength; a cast iron shell for durability.
2. Four to six times more heat absorption surface as obtained from bare tubes.
3. Reserve heat stored for sudden demands.
4. Least space for desired superheating effect.
5. Steam stays close to hot tube surface.
6. Can be applied to any make or type of boiler.

FOSTER
The SUPERHEATER
with the extended surface

Buckets of Brawn for Bearings

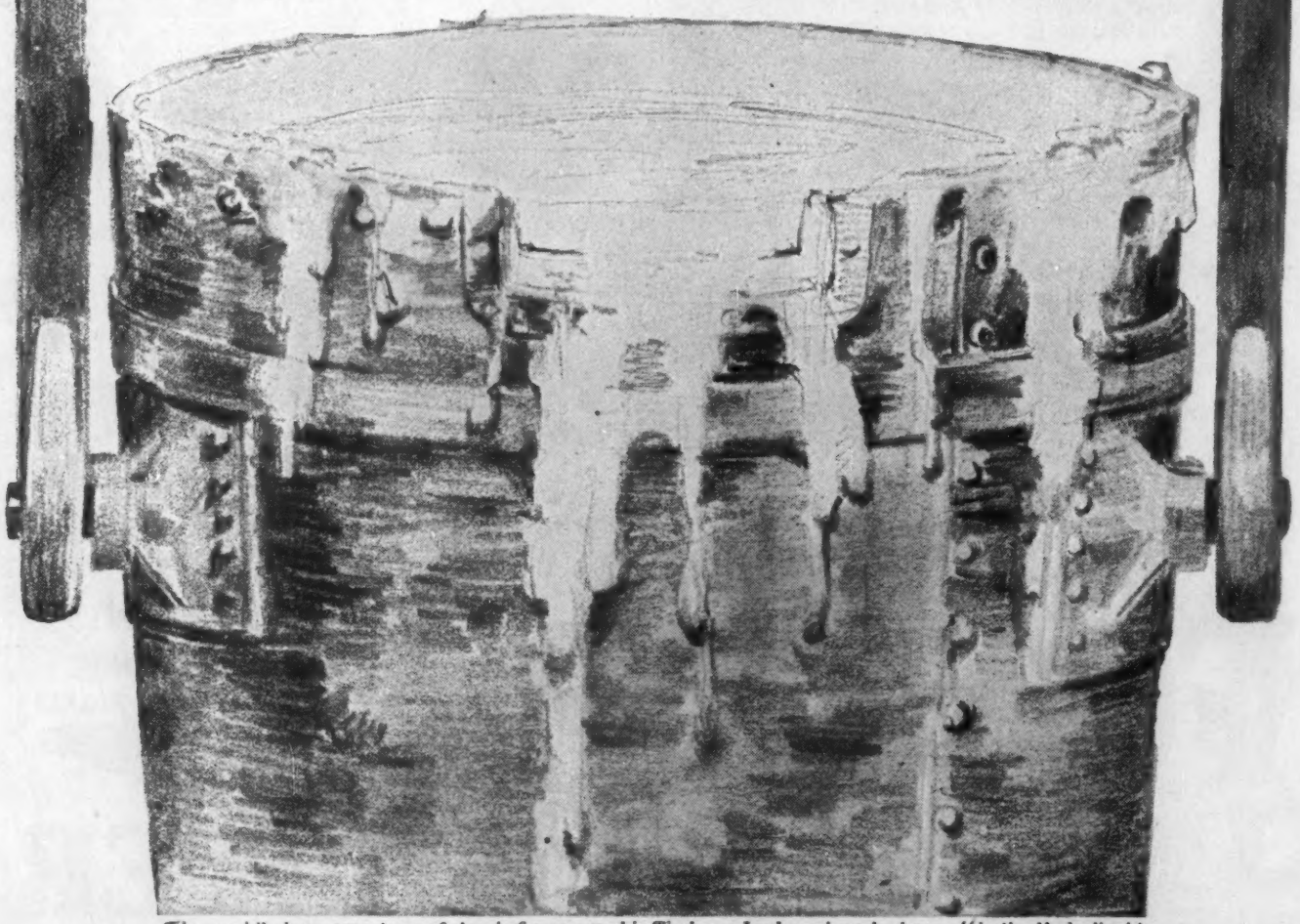
Wherever there is a Timken Bearing in machinery there is a point of hard service. That's just why each bearing is there.

For very vital reasons Timkens are awarded tough jobs in motor cars, trucks, tractors, machine tools, electric motors and other mechanical devices throughout transportation, agriculture, manufacture, and all other divisions of Industry. Timken Tapered design provides for the inevitable "side-thrust" on bearings, which best engineering dare not ignore. Timken positive roll alignment, exclusive, adds to bearing speed possibilities. And only Timken, in its field, produces its own electric bearing steel.

Finest material for the worst work in machinery is assured by the complete, extremely modern Timken steel plant which is part of the great self-contained Timken Bearing industry.

Such resources and facilities could be reared on nothing but the engineering success of some 150,000,000 Timken Bearings. Facing an engineering career, you will be facing the universal preference for machinery designed around Timken Tapered Roller Bearings. It will be well to know Timkens. The little stiff-bound Timken book, sent gratis upon request, will tell you much.

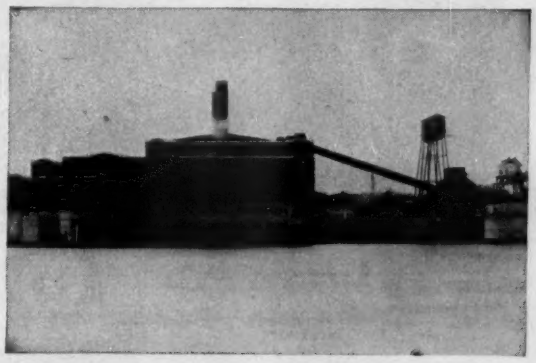
THE TIMKEN ROLLER BEARING COMPANY
C A N T O N , O H I O

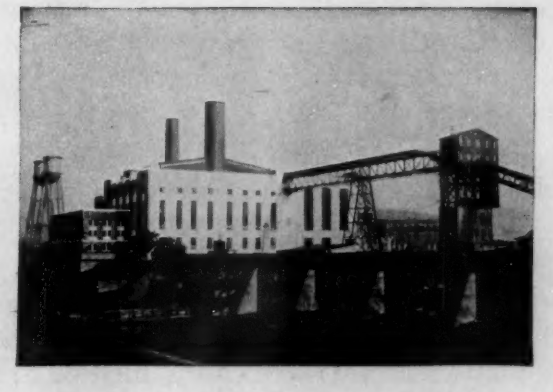


The world's largest producer of electric furnace steel is Timken. In these giant buckets or "ladles," the liquid Timken steel leaves the furnaces to go through all the processes of manufacture, entirely within the Timken plants

TIMKEN *Tapered Roller* **BEARINGS**

Three Unusual Public Servants





Sargent and Lundy Engineers of these Power Stations

These public utility power stations, constructed by The Foundation Company, are now contributing to the welfare of the communities they serve.

The Power Station of the Columbia Power Company, near Cincinnati, Ohio, contains the latest developments in steam and electrical generation. It has a present capacity of 120,000 H.P. which will be ultimately increased to 480,000 H.P. Ground was broken February 14, 1924, and power was generated December 10, 1925,—such the record for construction.

In the heart of the Kentucky coal fields a steam power plant has been constructed, designed to utilize fuel near its source and transmit electrical energy to nearby industrial centers, including the mines from which the fuel is taken. This $3,500,000 station of the Kentucky Utilities Company, near Pineville, Kentucky, is a link in a chain of super-power stations in this region.

At Philo, on the Muskingum River in Ohio, is situated a power plant of the Ohio Power Company which has become noted for its economical operation. Located where a navigation dam makes a considerable difference in level in the river, water for condensing is taken above and discharged below the dam without pumping. Unusual efficiency is obtained with the most modern fuel handling machinery in both wet and dry storage.

Power plant construction is a specialty of this organization.

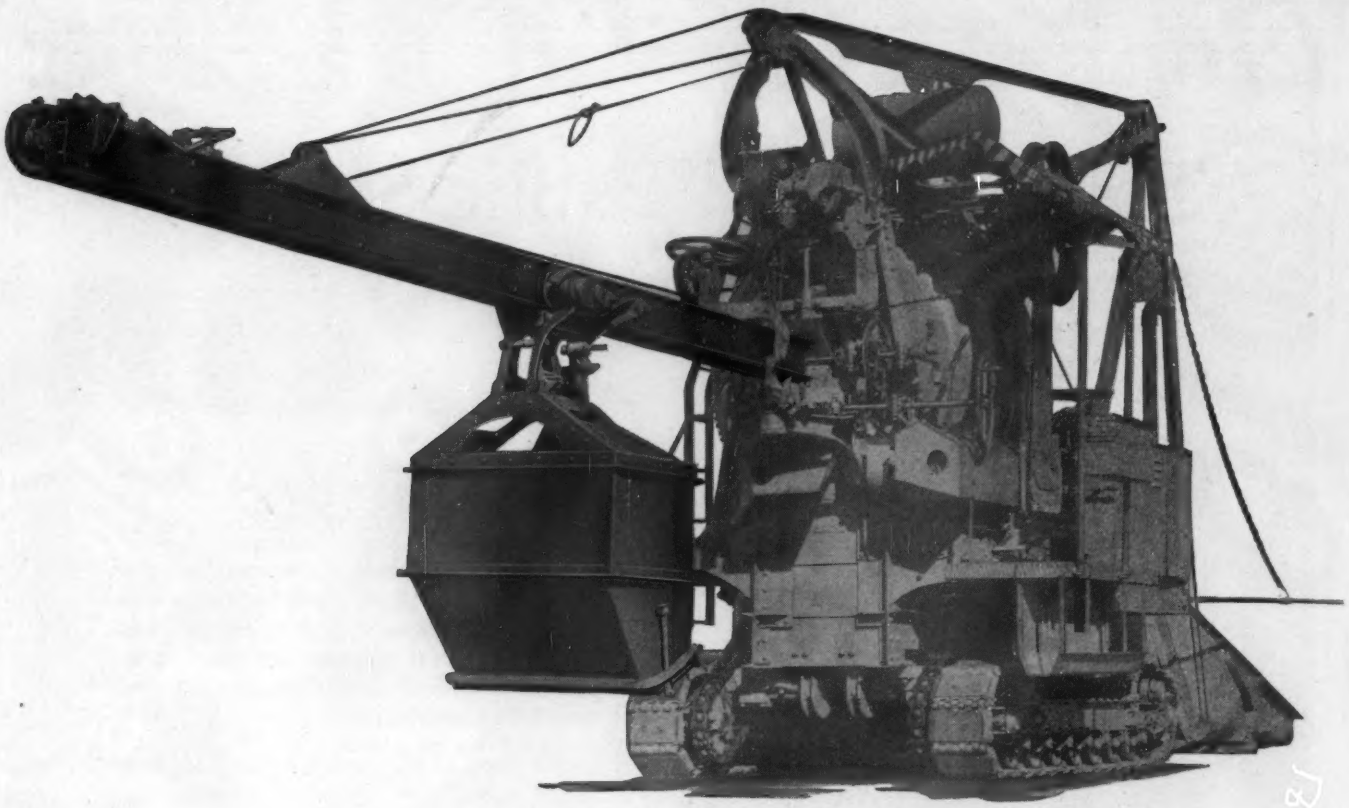
THE FOUNDATION COMPANY

CITY OF NEW YORK

Office Buildings . Industrial Plants . Warehouses . Railroads and Terminals . Foundations
Underpinning . Filtration and Sewage Plants . Hydro-Electric Developments . Power Houses
Highways . River and Harbor Developments . Bridges and Bridge Piers . Mine Shafts and Tunnels

ATLANTA	SAN FRANCISCO	MEXICO CITY	LONDON, ENGLAND
PITTSBURGH	LOS ANGELES	LIMA, PERU	BRUSSELS, BELGIUM
CHICAGO	MONTREAL, CANADA	CARTAGENA, COLOMBIA	TOKYO, JAPAN

BUILDERS OF SUPERSTRUCTURES AS WELL AS SUBSTRUCTURES



Boom and Bucket Distribution

THE Koehring Company provided means for producing Standardized Concrete long before its importance was generally recognized. At the same time the vital importance of operating speed and the saving of time on the job has always been a fundamental consideration in designing Koehring Pavers and Mixers.

One of the basic units of the standard paver, produced in conformity with these principles, is the boom and bucket system for delivering mixed concrete from the drum to the subgrade, developed and perfected by Koehring Company.

This unit because of its many automatic actions cuts down to a minimum the time for placing the mixed concrete on the subgrade; and because it is possible with this method to maintain a uniform and proper consistency of the concrete from the drum to the subgrade without separation of aggregate, the Koehring boom and bucket is an important factor in producing standardized concrete of dominant strength.

Today, the Koehring boom and bucket, Koehring batch meter, Koehring five action re-mixing principle, and the Koehring automatic water measuring tank provide the most positive and accurate means for producing standardized concrete of unvarying uniformity yet devised.

"Concrete — Its Manufacture and Use" is a 210 page treatise on the uses of concrete, including 26 pages of tables of quantities of materials required in concrete paving work. To engineering students, faculty members and others interested we shall gladly send a copy on request.

KOEHRING COMPANY
MILWAUKEE WISCONSIN

MANUFACTURERS OF PAVERS, MIXERS—GASOLINE SHOVELS, CRANES AND DRAGLINES

Volume VII | Cambridge, Mass., May, 1926 | Number 3

Copyright 1926 by The Tech Engineering News

Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920.
Published monthly throughout the school year by the undergraduates of the Massachusetts Institute of Technology for the purpose of disseminating news of scientific and industrial interest and of promoting closer co-operation between Alumni and undergraduates.

THE MANAGING BOARD

GEORGE B. DARLING, '27
Editor

EDWARD D. TRUE, '27
General Manager

JAMES P. F. PILKINGTON, '27
Business Manager

MARSHALL W. JENNISON, '27
Managing Editor

JOHN A. CARVALHO, '28
Advertising Manager

WINTHROP H. TOWNER, '28
Associate Editor

JOHN S. MIDDLETON, '28
Circulation Manager

ROBERT A. NADLER, '27
Publicity Manager

EDITORIAL DEPARTMENT

THE EDITORIAL BOARD

R. A. McLACHLAN, '26, Assistant Editor
F. T. KURT, '27, Assistant Editor
J. J. MAZZONI, '29, News Editor
T. H. SPELLER, '29, Assistant Managing Editor
A. K. STRICKER, Jr., '29, Features Editor

STAFF

N. H. BALL, '29
K. R. ERDMANN, '28
G. J. MEYERS, Jr., '29
J. M. RYAN, '27
H. MOSER, '27
A. A. RANKIN, '28
C. D. RANKIN, '28
T. H. SPELLER, '29
A. K. STRICKER, Jr., '29

BUSINESS DEPARTMENT

THE BUSINESS BOARD

H. B. ELLISON, '28, Assistant Advertising Manager
R. E. CRAWFORD, '28, Assistant Circulation Manager
W. BAUMRUCKER, Jr., '29, Assistant Advertising Manager
W. H. PHILLIPS, '28, Assistant Advertising Manager

STAFF

W. BAUMRUCKER, Jr., '29
P. V. KEYSER, '29
A. H. PEARSALL, '28
W. H. PHILLIPS, '28
C. J. CRISTOFALO, '28
H. G. PRATT, '28
E. P. WEATHERLY, Jr., '29
A. TAMMARO, 28
D. H. WILSON, '29
C. J. CUSTER, '29
C. F. HOLDREGE, '29
J. E. HOWARTH, Jr., '29
W. G. SMITH, '28
R. W. STOBER, '27

THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

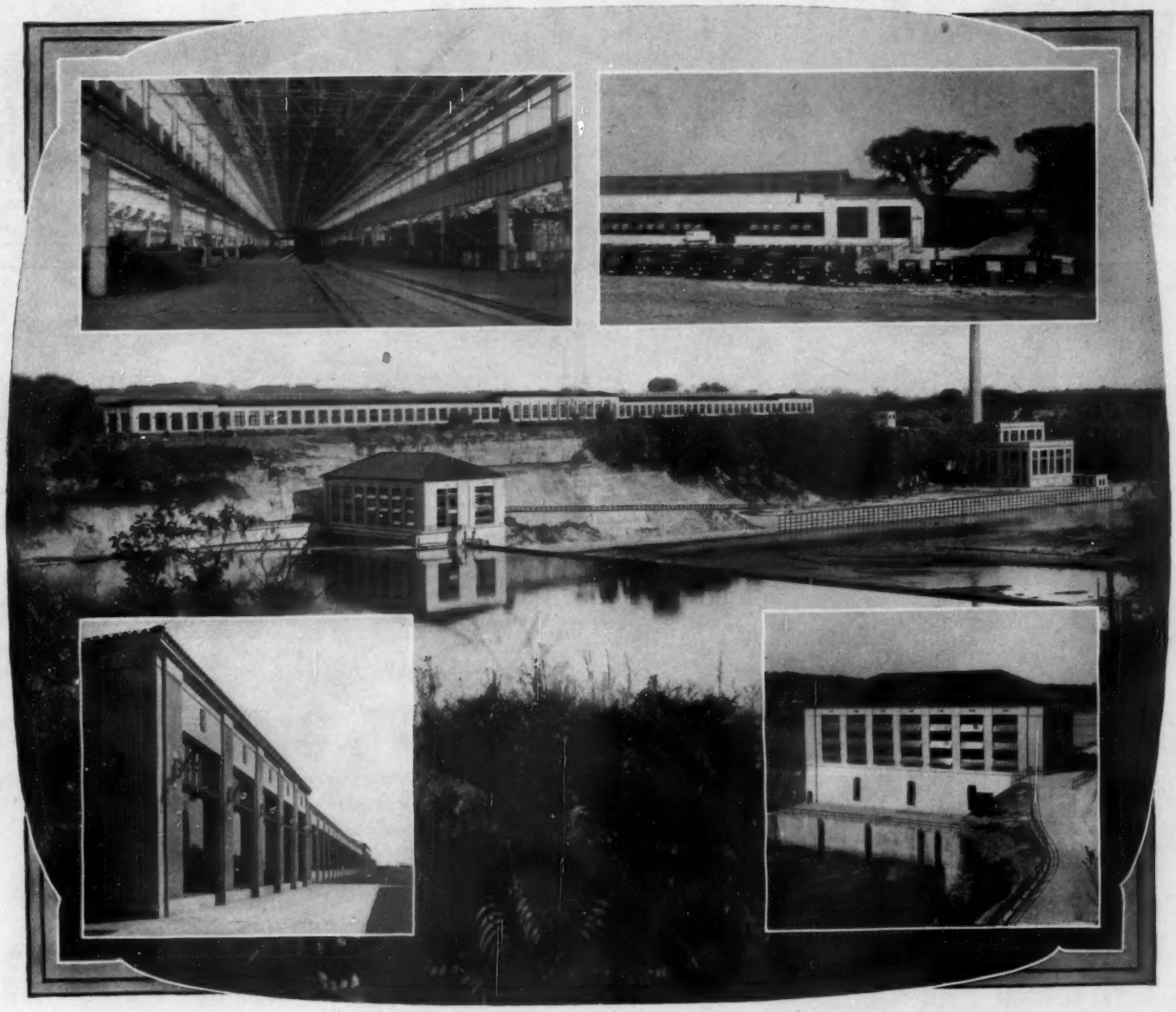
Chairman, Prof. Leslie F. Van Hagan, Madison, Wisconsin

The Transit
Iowa Engineer
Colorado Engineer
Nebraska Blue Print
Pennsylvania Triangle
Sibley Journal of Engineering
Purdue Engineering Review
Rose Technic
Michigan Technic
Ohio State Engineer
Minnesota Techno-Log
The Tech Engineering News
University of Virginia Journal of Engineering
Wisconsin Engineer
Penn State Engineer
Technograph
Cornell Civil Engineer
Kansas State Engineer
Kansas Engineer
Princeton E. A. News Letter
Armour Engineer

Subscription, per year, $1.50
Address all communications to The Tech Engineering News, Walker Memorial, Cambridge 39, Massachusetts. Telephone, University 6864
Advertising rates upon application

TABLE OF CONTENTS

	Page
A LETTER FROM AN ENGINEERING EXECUTIVE TO HIS SON	107
THE 1926 GRADUATE — PLANNING A CAREER. By Leroy D. Peavey, '98	108
BACTERIA — THE SMALLEST WORKERS IN INDUSTRY. By B. E. Proctor, '23	110
THE S. S. MALOLO. By E. P. Trask, '99	112
SOME UNUSUAL MARINE ACCIDENTS. By Prof. Evers Burtner, '15	114
THE TREND OF MODERN AMERICAN ARCHITECTURE. By Robert M. Blackall, '17	116
INSPECTION METHODS. By Prof. Earl Buckingham	118
FINDING AN ANTI-KNOCK MATERIAL. By Thomas Midgley, Jr.	119
EDITORIALS	123



Ford Twin Cities Plant

IN this Ford manufacturing plant designed and built by Stone & Webster at St. Paul, Minnesota, the ground area of the single-story main building is nearly 20 acres* and the capacity of the power plants, one steam and one hydroelectric, on the Mississippi, is 25,000 horse power. Albert Kahn was Associate Architect on the main building.

Materials for manufacturing enter the main building and are unloaded direct from the railroad cars. It is planned to have the finished product descend by elevator 100 feet to a terminal chamber and go thence by tunnel 700 feet to a boat landing for shipment by water.

*The building is 1400 feet long by 600 feet wide

STONE & WEBSTER

INCORPORATED

NEW YORK, 120 Broadway
PHILADELPHIA, Real Estate Trust Bldg.
BOSTON, 147 Milk Street
SAN FRANCISCO, Holbrook Bldg.
CHICAGO, First National Bank Bldg.
PITTSBURGH, Union Trust Bldg.

MAY 24 '26
©CIB701251

THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME VII — MAY, 1926 — NUMBER 3

A Letter from an Engineering Executive to His Son*

Extremely valuable advice for the engineering student, written by an executive of over thirty years' experience — an M. I. T. graduate to his son now at Technology

My dear Marshall:

Tomorrow you are to become an employee in one of the major industrial plants of the country, and I thought this an opportune moment to give you some advice, the results of some thirty years' experience in a similar plant.

First, as to your preparation for the job: You have been graduated with two degrees from the leading engineering school in the United States. Just what does this mean? It does not necessarily mean — note the word necessarily — that you are an engineer. It does mean, however, that you have spent five years at that institution and that you have completed in a manner satisfactory to the instructing staff the courses of study; and when the high standing of the school in educational matters is considered, this does mean that your work has been no child's play, but has required long hours of intensive application. It also means that you must have absorbed or retained a certain, and by no means inconsiderable, amount of engineering knowledge; otherwise you could not have successfully completed your course.

The Engineer Should Always Be a Student

This period in your life which you have just completed is commonly known as the student period. This in some respects is a wrong designation. In reality your student days are just beginning. You are now to become a student of real life, and the successful engineer forever continues to be a student. In your college days your problems were made to fit the student, they were bound to come out right, and the answers were usually to be found at the end of the book. The real problems that you are now to be called upon to solve have never been solved before; the answers are unknown. You must fit yourself to these problems. Some of them perhaps cannot be solved, but never admit that fact until you have exhausted every possible means of solution. In the various laboratories you have tested many samples both from a chemical and from an engineering viewpoint. You are now to test full-sized specimens, and in turn you are to be tested yourself. Do not overlook this last fact particularly. You are to be subjected to the acid test, the endurance test, and the breaking-strength test. See to it that you withstand them all.

The main object of your studies has been to acquaint you with the natural laws governing all mathematical, engineering, and chemical relations. You should have learned how best to approach the solution of a problem involving any of these relations. You are now to meet with these problems in real industry, and your education will have prepared you to work out their solutions in the quickest time and in the most efficient manner. Do not get the idea that the man who can carry the greatest number of formulas in his head is necessarily the most capable man, and that he who forgets them all is the least so. In my own class was an excellent instance of each of these types of men, but the man who could remember all the formulas never knew which one to use or how to use it, while the other fellow, although he could not carry them in his head, knew what formula to use, how to use it, and where he could find it when he wanted it. Formulas are like tools — possession of them is of no value unless one knows how to use them.

Practical Knowledge More Essential than Scientific Education

Never boast or brag of your education, particularly before those who have been less fortunate. They are likely to resent it, and it does you no credit. It is better to have persons get this information concerning you from others than yourself. Lack of education, while a serious handicap, is no disgrace; and the working boy who, by years of denial and hard work daytimes and studying at night, obtains a scientific education, is far more deserving of credit than he whose education has been financed by his parents. As you get deeper into your work, you will find that theory, which has played such a large part in your student work, is not all — in fact, it may be the lesser part by far. You will find that practical knowledge is all-important and that in this line the working boy far excels in the beginning at least.

Your first day at the plant is all-important. First impressions are likely to be lasting, and often has a man been forever handicapped by some misstep that he made the first day he met his new associates. Be careful of your appearance. No one but an out and out genius can afford to be slovenly in his dress, and such persons are rare these days. On the other hand, you must dress in keeping with your position and the nature of your work. It is not wise,

(*Continued on page 134*)

* Reprinted from *Power*, by permission.

The 1926 Graduate—Planning a Career

A thorough analysis of the economic factors the engineering graduate should examine in directing his endeavors

By LEROY D. PEAVEY, '98
President of the Babson Statistical Organization

THERE never was a time in the history of the country when the technical graduate had a better opportunity than today. In many respects we live in an engineering age. We live in a period when wide and sweeping changes are occurring in our national and economic life, and the technician is indispensable in the development of these changes.

To some extent this has always been true, but never to such a degree as now. Fifty or a hundred years ago the United States was largely agricultural. Industry since then has moved on apace, and more and more of the agricultural areas and agricultural population have been replaced by manufacturing and its allied pursuits. Business in 1926 is an overwhelmingly more important thing than it was in 1875 or even in 1900, and to all this the technical graduate must contribute.

Not only is this fact well established, but competitive conditions, both domestic and foreign, are such that a business can only now be successful by a very marked tendency toward improved efficiency in methods of manufacture and management. Business "runs itself" with less success than it ever did. There is no reason for the conduct of a business it if does not make money, and as never before the only way for it to make money is to reduce waste to a minimum, and increase production per unit in every way. The efforts of Secretary Hoover on this line during the last five years show what can be accomplished.

Another factor which emphasizes this very important trend toward greater efficiency is the long, gradual declining tendency in commodity prices. A glance at the Babsonchart diagram below will at once show that the zone of prices as evidenced by the single black line has been for the last five years considerably above that of the pre-war period. During the war, and in the wild inflation of 1920, prices were even higher. Since then they have "stepped down" to the zone of the last five years and are now working still further downward toward the old levels. This represents a very different period from that of generally rising commodity prices, and offers a fertile field for the endeavors of the trained technical man.

Suppose, for instance, one holds an important position in an enterprise during a long, upward price drift. A fundamentally different viewpoint and a fundamentally different policy are called for than when the price trend is downward. Moreover, when the long pull tendency of prices is upward, certain enterprises (such as public utilities with legally limited prices) may be severely handicapped, while other concerns which can advance quotations will make gratifying profits. Opposite conditions prevail when the long pull trend of prices is downward, as it is today. Many public utilities are now getting the advantage of lowering prices of materials and more or less stable rates for service.

This article is the sixth of the series to discuss the future of the technical graduate in the various professional fields. It is not limited, as were the others, to any particular field, but surveys the entire situation from the economic point of view. The author, from the position he holds, can present this aspect of the situation with authority. It is hoped that the series is of real service to the men in all classes who are confronted with the problem of deciding just what field of activity they will enter upon graduating.

This is an illustration of what the engineer must continually keep in mind. The technical man is perfectly familiar with the forces of physics, chemistry, etc., but he is too often blind to economic forces — so important to him and to the industry which he serves. He should have indelibly impressed on him the fact that if he is ignorant of economic forces, all the energy in the world of science will not save him from. business catastrophe. The very fact that the engineer is so highly trained tends to give him a false confidence, and thus he may be a prey to powerful economic forces.

The technical graduate in beginning his career, as well as all other collegians, must always have definitely in mind the condition of general business and in which direction it is moving. The Babsonchart diagram already referred to shows the temporary ups and downs of United States trade. It is true that decade after decade the country is forging ahead in a remarkable manner — that is, the average growth of the country represented by the line X-Y on the diagram shows a constant upward advance. In spite of this, however, the temporary periods of over-expansion and readjustment have a very vital effect on trade and on employment.

Incidentally, it is very much harder to secure a good position in a period like 1921 or 1914 than in the wonderful activity of 1906, or 1916, or 1919. This, many graduates in those unfortunate years found to their sorrow. Again, the general procedure, method of attack, and whole mental attitude of the worker must be entirely different when business is vigorously advancing from his attitude when a decline is in force. Suppose there are two engineers of equal ability. One takes hold of an enterprise at the bottom of one of these upward swings, and with the help of fundamental conditions makes such a success that it becomes firmly established and can readily survive subsequent depressions. The other man is active in an enterprise at the top of a downward trade swing and finds the course of business working against him. He may not only weaken the enterprise, if he does not understand these laws of trade, but the business may collapse altogether, and severely cripple his morale and change his entire career!

The successful engineer, then, like all other men, is constantly familiar with business conditions. At the present time we are in a substantial area of good business above the average "X-Y Line" of the country. While general business during the balance of 1926 may not be as good as for the recent six months, there is a probability that graduates who are reasonably alert will find conditions favorable enough. Monetary, industrial, and employment conditions show no sign of immediate stress.

In selecting a life-work the graduate must of course decide whether he wishes to undertake the more professional occupations of teaching or pure laboratory research in some form or other, or whether he will devote his talents to the furtherance of business in one of its many and varied phases. In each there is abundant room for an honorable and successful career. The true engineer in either sphere can perform his legitimate function of "adding something worth while to what has already been done." If he does not fulfill this requirement, his life will be of no avail.

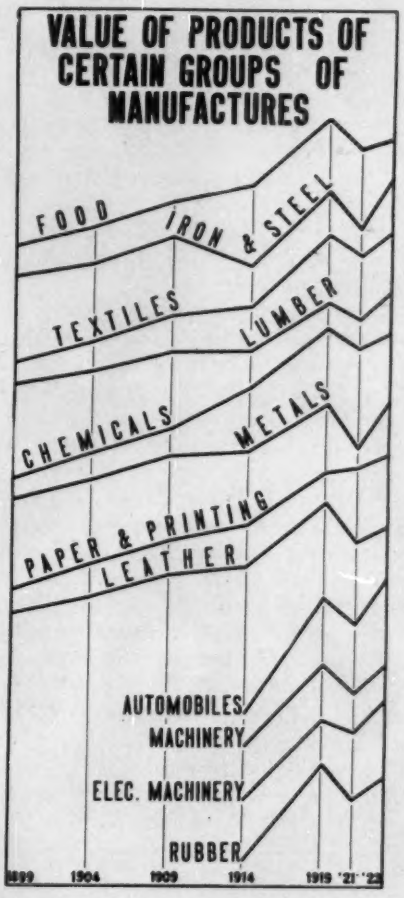
He must follow in the illustrious path of his predecessors who have civilized and made habitable the trackless wastes, caused the deadly swamp-infected areas to teem with life, brought the ends of the earth into vital and easy communication, or made possible the wonderfully efficient factory processes of the twentieth-century world! He must, if he would rise at all

above a mere mediocrity, have a tremendous vision, and yet be so balanced by his practical viewpoint that the products of his labor will abundantly contribute to the advancement of society.

By far the larger number of technical graduates will not adopt the pure research occupations, but will enter some phase of business activity. To them especially we would emphasize the fact that they can progress only by making themselves increasingly useful to their employers. Science for science's sake is commendable, but the man who in the busy whirl of business makes computations simply to obtain an answer, or the man who holds a test-tube simply to obtain the resulting reaction, will never get very far. In fact, as far as business is concerned, it has no interest in such processes at all unless the results can be utilized to secure greater efficiency of processes, to perform a greater service to customers, and thereby increase the profits of the concern.

Some readers of this article do not need to be reminded of these facts, but by far the majority of young engineers need constant admonition along this line. What does your employer care how many lines you draw on paper, or how many hours you spend on factory process, if the business is not materially benefited thereby? The progress of the business is the goal to be kept in mind, and the rewards are commensurate only with the achievements of this goal. As this article is being written an announcement comes of a mammoth endowment for pure research operated by Mr. Hoover and associates. This is for university laboratories, but will contribute heavily to industrial progress.

It is with this fact in mind that the technician in the commercial field should, if possible, couple his capacity for management and organizing ability with his scientific skill. He should aim

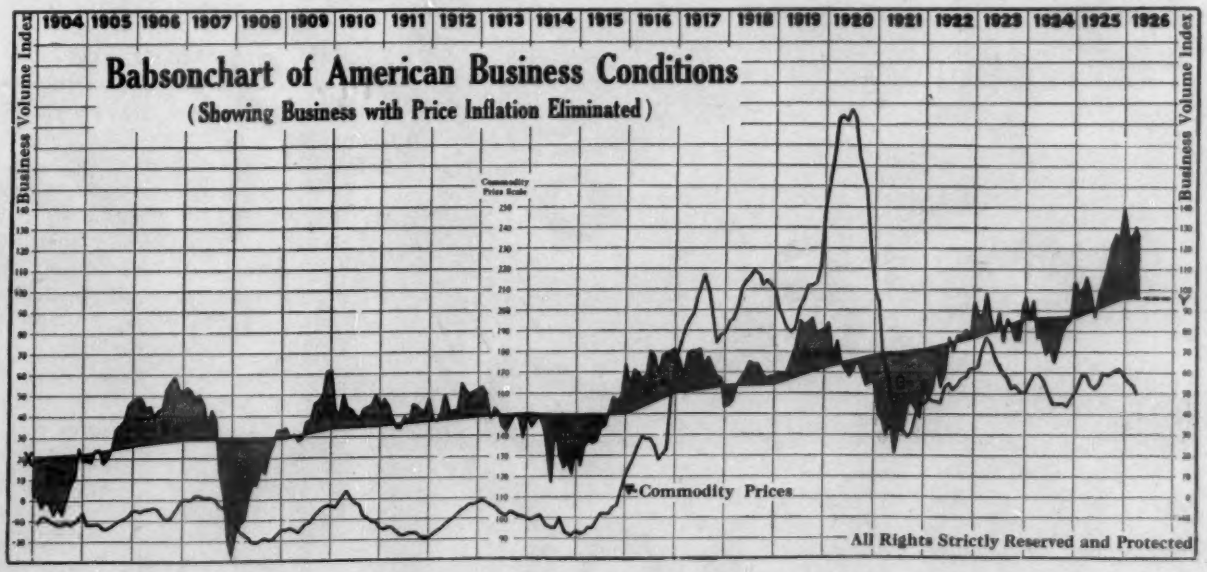


at eventually becoming an organizer or an executive in some form or other. A mere "engineer" may not obtain a salary proportionate to his real ability, and the time and money expended for his training, unless, of course, he specializes intensively in some one form of work. (It is true that there are some notable exceptions, like the late Steinmetz, who are especially gifted by nature with a certain intensively developed mental phase, but these are *only* exceptions.) To those, then, who may not posses the powers, or who have a distaste for a business career, the clarion message is — "Be an expert on some one line. Know more about that particular subject than anybody else in the world!"

The great consideration for the mass of young graduates is, however, to select and train in a business where you will not only function as a technician, but ultimately as an executive or owner — at least a director of an important part of it. This statement does not simply have in mind the monetary reward. The question of authority and power is also vitally involved. If the young man is not careful, he will get into a pocket or rut. He is at first placed in a very subordinate position, and it will be unfortunate if he allows himself to stay there. The successful man initiates and plans, and the engineer of the business type has full play for these necessary qualities. In such a capacity as above described, one has a breadth of opportunity even for scientific accomplishments which otherwise might be denied him.

It is gratifying that in recent years our engineering schools are recognizing the extreme value of better information along general economic and business lines, in order that their graduates may have a proper background as they enter the arena of activity. This is as it should be, but the individual must himself make sure of surrounding him-

(*Continued on page 130*)


1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926
Babsonchart of American Business Conditions
(Showing Business with Price Inflation Eliminated)
Business Volume Index
Commodity Price Scale
Commodity Prices
All Rights Strictly Reserved and Protected

THE BABSONCHART, WITH CORRECTED CURVES

Bacteria — the Smallest Workers in Industry

An extremely interesting account of some of the activities of these universal workers from a practical viewpoint

By B. E. Proctor, '23
Department of Biology and Public Health, Massachusetts Institute of Technology

MEMBERS of the engineering professions have but a vague knowledge of bacteria and their uses. In general a bad cold or a slight influenza epidemic recalls the fact that there are such organisms in the universe, although the idea is often expressed that humanity would be much better off without them. This point is conceded as far as those types of bacteria connected with disease, but for each type associated with diseases, and they are comparatively few, there are hundreds of others which are working to help mankind.

Bacteria are the smallest living things which we are able to distinguish even with the aid of a microscope. They are seldom more than a few thousandths of a millimeter in length, and there may be millions present in just a small drop of liquid, but in spite of their diminutive size, these microorganisms are able to accomplish feats of considerable magnitude.

Without the labors of some groups of bacteria, we should need thousands of nitrogen fixation developments, such as has been proposed at Muscle Shoals. Members of these groups, the so-called nitrifying types, are able to take nitrogen from the air and convert it into more complex nitrogenous compounds, which in turn are available for the nourishment of food crops. Of course this process has been going on in nature for centuries, but it remained for science to discover that only certain legume plants, like clover, alfalfa, and peas, would foster these organisms. Immediately thereafter farmers were instructed to rotate their crops and plant clover or alfalfa once in two or three years to enrich the nitrogen content of their land and increase their crop production. The work these nitrogen fixing organisms do may be imagined, as Whiting, at the Illinois Experiment Station, has calculated that if the nine more important crops grown in the United States were to be furnished all their nitrogen requirements by the application of the nitrate of soda, which is at present the most important commercial nitrogenous fertilizer, the world's supply of this material would be sufficient for the United States alone for only about six years.

These organisms require no attention after being sown once with clover, but there are many other kinds of bacteria which have to be carefully trained to carry out particular tasks and which work only under very specific conditions of temperature, acidity and oxygen supply.

An example wherein bacteria are used to accomplish a specific purpose is in the production of vinegar from cider. Everyone in New England will admit they are acquainted with cider, sweet or otherwise, but very likely the changes which occur between its origin as a sugar-containing juice of the apple and the sour solution of dilute acetic acid called vinegar are a mystery. First, the sugars of the apple are converted to alcohol by the action of yeasts which are quite closely related to bacteria from a biological standpoint. This alcohol is then oxidized to acetic acid by the action of acetic acid bacteria. Unless sweet cider contains some substance such as sodium benzoate to stop this action the process will go on spontaneously, because both yeast and bacteria are always present on the skin of the apple, but it requires several weeks for the alcohol to be completely transformed to vinegar in a natural way. It was found that by increasing the number of bacteria and the amount of oxygen present the same results could be accomplished in several hours. This process is now used industrially in making vinegar by cultivating large numbers of acetic acid bacteria on beech shavings and allowing the alcoholic cider to trickle down over them in the presence of a generous oxygen supply. The shavings present a tremendously large surface area and thus facilitate the more rapid chemical action by the organisms.

Bacteria were drafted into the services of the Allies during the World War as a result of one of their functions. The manufacture of explosives demanded enormous amounts of acetone as a solvent, but the supply was limited to that obtained from the destructive distillation of calcium acetate. New methods of making acetone were vitally essential and numerous scientists went to work on the problem. Certain bacteria were known to have the ability to act on carbohydrates and form acetone along with other organic products, so experiments were carried on with these particular types of organisms. A small plant was started in England using potatoes as the source of raw carbohydrate material, but the great increase in their price made their use prohibitive. Broken rice was next

VARIOUS ORGANISMS AND RAW MATERIALS USED IN RESEARCH STUDIES ON BUTYL ALCOHOL PRODUCTION BY FERMENTATION, DEPARTMENT OF BIOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The final product is butyl alcohol. Some of the intermediates are acetone, a dye, and iodoform.

tried out, and proved quite satisfactory, but the German submarine embargo soon cut off this source of supply. Corn or maize was found to work well, and plans were made to ship this raw material to England both from Egypt and the River Platte. Again difficulties rose, as the United States was now entering the War and all shipping was needed for troop transports. In the latter part of 1917 things had come to a point where extensive plans were made to have the women and children in England gather horse-chestnuts to be used for the manufacture of acetone by bacteria. These horse-chestnuts were really unsuited for the purpose, however, due to difficulties in removing the heavy outside coating of bark which contained æsculin, a compound which interfered with the necessary bacterial action.

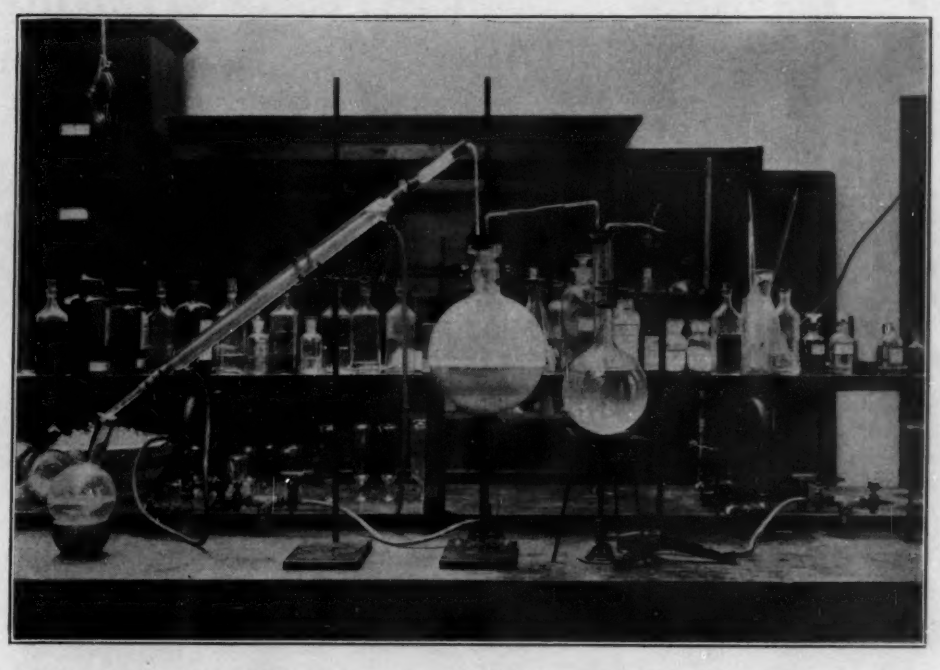
The development work had been established on a practical basis by this time, but it was seen that the only logical means of combating circumstance was to move the production centers to the sources of raw material. With this in mind the British War Ministry took over some large distillery properties in Toronto for the production of their acetone, and shortly afterward the United States established two plants of a similar nature in Terre Haute because of their location so near to our own great corn-producing regions.

For a long time before the War was over, these plants were producing tons of acetone daily, but the demand was steadily increasing because acetone had found another important use besides explosives. It was being used as a solvent in wing-dope, the treatment given airplane wings to cut down the effects of atmospheric exposure.

All bacterial organisms do not produce acetone from corn and such carbo-

SOME OF THE "AZOBACTER," A SPECIES OF NITRIFYING BACTERIA FOUND IN THE SOIL .X 1000
From Jordan after Zettnow

These bacteria are able to take nitrogen from the air and make it into food for plants.



STEAM DISTILLING APPARATUS USED IN THE FERMENTATION RESEARCH WORK BEING CONDUCTED BY MR. K. MORIKAWA IN THE DEPARTMENT OF BIOLOGY

hydrate materials, in fact the types which can are very limited. When such a type has been found, extreme precautions must be taken that other organisms are not present which will interfere with the process and possibly prevent the formation of the product wanted. On the other hand, when acetone is produced, there are always other organic products formed as well. In this case, under the conditions needed to produce acetone, there were also produced butyl alcohol and a small amount of ethyl alcohol in the fermented mash.

During the War butyl alcohol was a by-product which had little use. Since the War butyl alcohol has found several important uses, such as in the better motor car finishes, as a solvent, and in the production of certain film materials, so that the by-product is now as important as acetone, which decreased both in price and use after the War. Between these two products and their wide uses as solvents the process has become quite well established commercially.

Two other bacterial methods were developed during war time to help speed up the production of acetone. One involved the use of molasses as a raw material to produce acetic acid in the same way vinegar is made, after which calcium acetate was formed. In the other process the giant kelp of the Pacific Ocean was gathered in tremendous amounts, transported to land in barges, and fermented with bacteria to produce acetic acid, ethyl acetate, ethyl propionate, and ethyl butyrate. One plant alone turned out twenty-four tons of acetic acid or its equivalent in acetone daily using this method. Neither of these special industries survived the period of declining prices of acetone however.

Bacteria have some good qualities, as we have seen above, but they also may work to the disadvantage of mankind. Spoilage of goods amounting to millions of dollars annually is caused by the same bacteria. Plant products, such as textile fibers and rubber latex, are also subject to their depredations. Bacteriological laboratories spend a much larger proportion of their time developing methods of prevention of spoilage by bacteria than the utilization of bacteria for the production of certain commodities. Studies on the growth conditions have shown that temperature and moisture are two of the most important factors in their development. As a result we now preserve in glass or can a large percentage of our foods, heating them to such temperatures that the bacteria are killed, in order to prevent spoilage. Our meats and vegetables are also placed in cold storage for the reason that bacteria are unable to carry on their activities to the same extent at low temperature as they would otherwise. Argentina has become a large meat-producing center because refrigeration enables meat to be shipped from South America to Europe and the United States, where it arrives in perfect condition and competes with local products. Citrus fruits which were once thrown away because of spoilage by micro-organisms are now shipped from California to the Eastern markets by refrigerator cars. It would be difficult

(*Continued on page 154*)

The S. S. Malolo

A complete description of the largest and fastest steamship ever built in this country

By E. P. Trask, '99

Assistant Naval Architect, Wm. Cramp & Sons Ship & Engine Building Co.

At the present time, fast express service westbound for passenger transportation terminates at the Pacific Coast, but with the advent of the *S. S. Malolo*, now being constructed for the Matson Navigation Company at the plant of the Wm. Cramp and Sons, Ship and Engine Building Company in Philadelphia, the terminal will be moved about 2000 miles west to Honolulu. This ship, which is being built for first-class passenger accommodation, will be able to make the run in less than four days, and will form a fitting adjunct to Pullman trains now crossing the continent.

The principal dimensions and characteristics of the *Malolo* are as follows:

Length over all	582′–0″
Length on 26′–0″ waterline	577′–0″
Beam	83′–0″
Depth to shelter deck	44′–6″
Max. draft	28′–6″
Deadweight on 28′–6″ draft, about	8250 tons
Sea speed	21 knots
S. H. P., total available	25,000

Before settling on the final design, several arrangement schemes were evolved and the dimensions changed, the latter gradually increased. Especially did this apply to the breadth, as it was desired to maintain a wide margin of stability under all conditions of loading.

Subdivision of the ship is unusually extensive, there being twelve watertight transverse bulkheads extending to the shelter deck, which amidships is 16′–0″ above the load waterline. There is a double bottom 57″ deep extending from the forepeak bulkhead as far aft as possible. For one of this class, the vessel is of exceptional fineness, the block coefficient being about 0.55.

To gain the maximum in length on the waterline with the minimum length on which the size of the steel structure parts is based, the cruiser type of stern was adopted. This permits the use of an entirely submerged rudder. Also, in this case, the screw type steam steering gear is below the waterline.

The rudder is of the balanced type. It is broad at the top to conform to the shape of the hull in the vicinity of the stock opening and tapers to the usual thickness at its after end. Its area is 281 square feet and it is turned by a rudder stock of cast steel 23″ outside diameter, having a 7½″ axial hole. The rudder consists of a cast steel frame having a plate on each side to present a smooth surface. Wood filling with preservatives fills the spaces between the frame arms. The total weight of the rudder and stock is about 40 tons.

The propeller shafts are encased in bossing of unusually large size, which permits access to the shafts and structure with a facility seldom obtainable. The moulds for this bossing as set up in the mould loft are shown in the accompanying photograph.

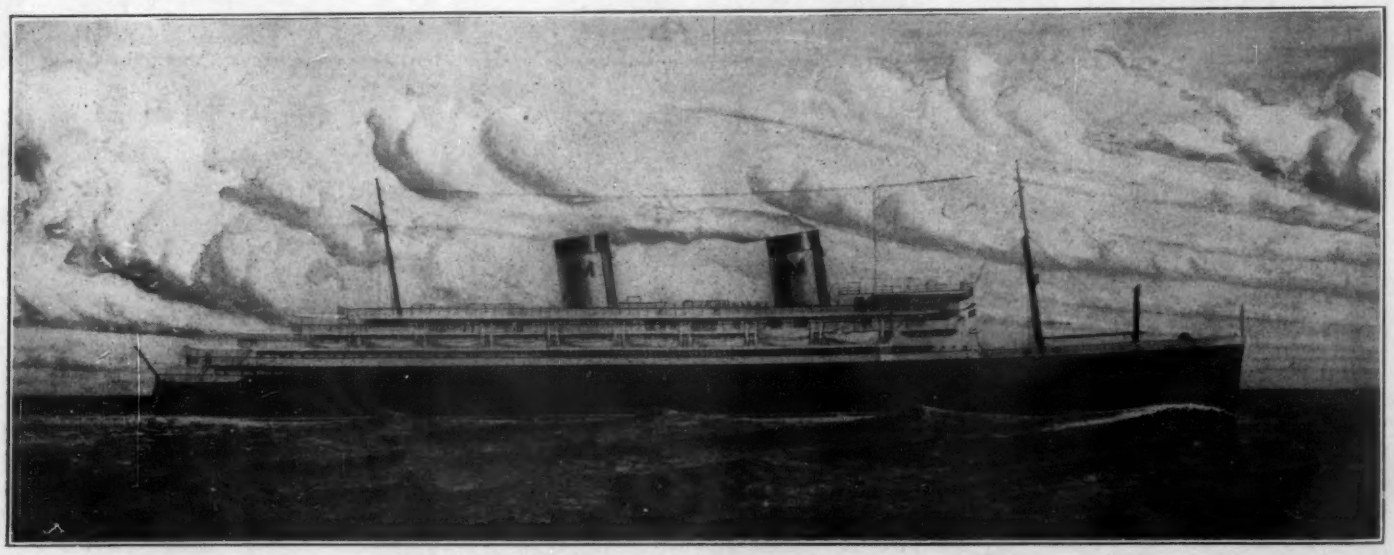
As a resistance to rolling, bilge keels 33″ deep are provided amidships. These are of the usual naval type and filled with wood.

The photo shows in a general way the type of template used in the modern method of shipbuilding. These templates are made from the body plan, which is a series of cross sections of the ship's hull taken on every frame and drawn full size on the floor of the mould loft or space where templates are made. Templates are usually made of bass wood or other clear, soft wood, and show the contour of all frames, and also on them are indicated the location and size of all rivet holes and whether the hold is countersunk or plain. For brackets and plates forming decks, bulkheads, or shell, templates are made to conform to the outline of the plate, and cross pieces define the location of lines of holes extending across the plate. Templates for plates are also made of heavy paper which has a minimum of shrinkage.

Fuel oil is carried in three sets of tanks: one set forward of the boiler rooms, one between the boiler rooms and engine rooms, and one aft of the engine rooms. There are thirty tanks in all, which have a total capacity of about 4500 tons.

Cargo is carried forward and aft of the machinery space, the total volume available being about 225,000 cubic feet, and of this about 18,000 cubic feet are insulated. The after cargo spaces are on a deck which is at the load waterline, and are loaded and unloaded by four inclined cargo conveyors which pass through the deck over the cargo spaces to side cargo ports above.

Passenger accommodations are unusually complete. There are 43 staterooms with one bed, 57 with two beds, 26 with one bed and one Pullman berth, 146 with two beds and one Pullman berth, and 8 de luxe rooms with two beds. In addition, there are 27 sofa berths, which make a total passenger accommodation of 690, in 280 staterooms; 145 of these staterooms have private bathrooms. On two of the



THE S. S. MALOLO AS IT WILL LOOK WHEN COMPLETED

This ship is to be used for trans-Pacific passenger service.

decks, every stateroom is connected with a private bath or toilet.

The dining-saloon extends the full width of the vessel and is 132′–6″ long, and has a seating capacity at small tables of 496 persons.

The galley and pantries and similar spaces are of exceptional completeness, and occupy a space about 90′ long, immediately aft of the main dining-saloon. The galley ranges are electrically operated as well as several other pieces of galley equipment.

Two elevators extend through the passenger spaces.

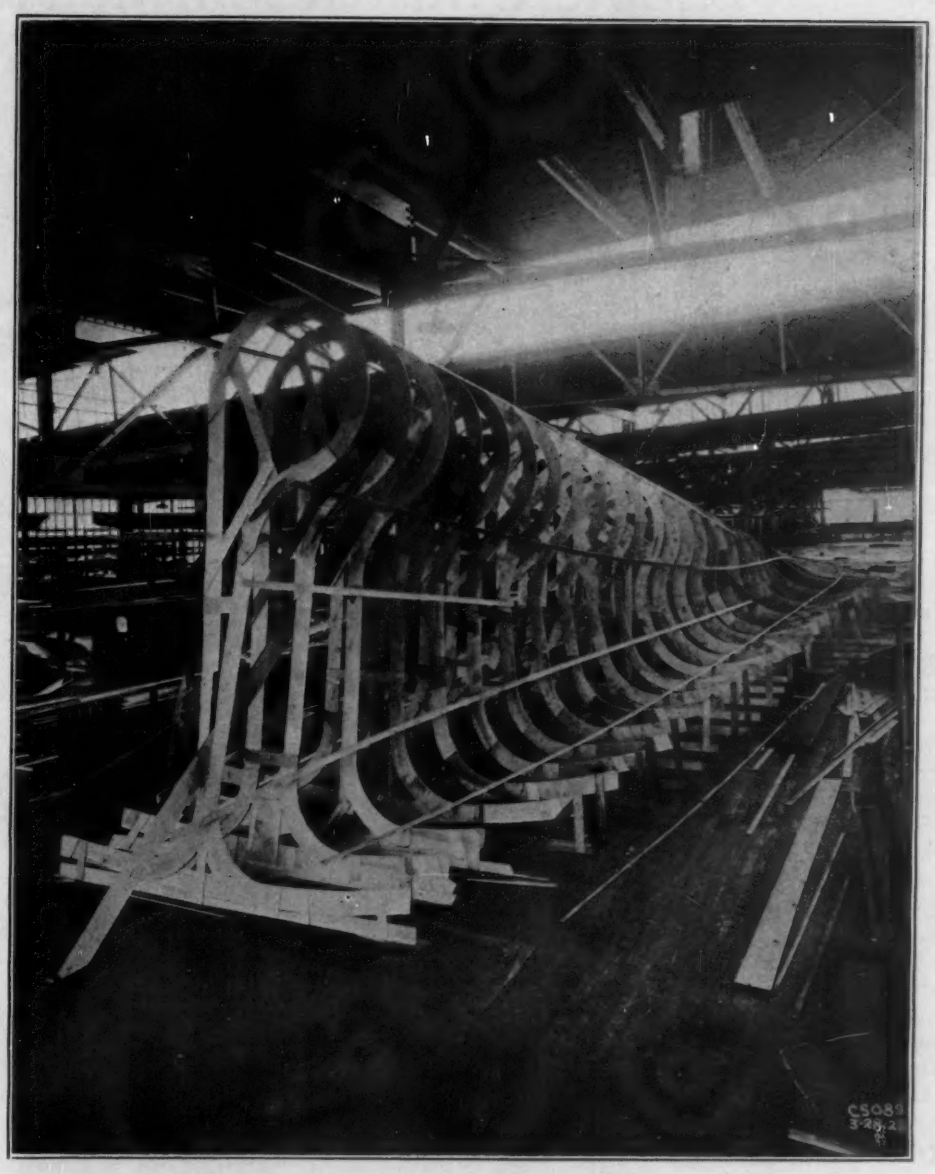
The sun deck is given over entirely to public rooms such as library, writing-room, lounges, smoking-room, and veranda. The total length of these enclosed spaces is 318′. On each side of the promenade deck there is a glass-enclosed promenade 222′ long and about 12′ wide. On the uppermost deck there is a children's game space surrounded by netting about 9′ high. Two places are available for the showing of motion pictures, one inside and one out. A swimming-pool, 30′ x 20′, together with a well-equipped gymnasium and electric baths, is available for the passengers' enjoyment.

The crew of such a vessel consists of 54 men in the navigating department, 60 in the engineering department, 214 in the stewards' department, and 8 musicians — a total of 336 persons.

The steel structure of the vessel is in excess of the requirements of the American Bureau of Shipping and Lloyds' Register of Shipping, with both of which societies the vessel is classed. As the depth to the promenade deck, which is the strength deck, is 54′, the ratio of length to depth is only 10.7, which is unusually low. To further relieve the top houses of possibility of damage due to the working of the structure, two expansion joints are fitted. The longitudinal stresses in this vessel due to floating among waves are much less than is usual in vessels of this size.

In accordance with present-day practice in large vessels, the frame spacing amidships is 36″. In the peak tanks the spacing is 24″, and gradual change of spacing occurs between these.

The sizes of some of the principal parts of the steel structure are as follows: bottom shell plating, .84″ for one-half length amidships gradually reduced to .60″ at the ends of the vessel; side shell plating, .76″ amidships to .54″ at the ends; flat keel plate, 1.00″ thick amidships tapered to .88″ at the ends; center vertical keelson, .64″ thick for one-half length amidships reduced to .54″ thick at the ends of the vessel; inner bottom plating, .66″ thick in the boiler rooms, .68″ thick in the engine rooms; plating gradually reduced to .50″ at the ends of the vessel; promenade deck or strength deck, .60″ thick for one half the vessel's length amidships reduced to .40″ at the ends; deck beams supported by four rows of pillars 8″ x 3.45″ x .375″ channels; main frames in holds and lowest 'tween deck space, 10″ x 3½″ x .50″ channels and 10″ x 3½″ x .475″ thick channels; main frames above these, 8″ x 3.45″ x .375″ channels.



A VIEW IN THE MOULD LOFT

The moulds for the shaft bossing for the S. S. Malolo, under construction.

Resistance to transverse distortion of the hull is obtained by the bulkheads and by an extensive system of web frames and partial bulkheads which extends into the deck houses.

The life-saving equipment includes sixteen 28′ metal lifeboats, two 30′ steel motor-driven lifeboats, and two 20′ wooden work boats, also available for lifeboat use. The total passenger capacity of the boats is 1016 persons. Each of the motor-driven lifeboats is to be equipped with a ½ K.W. radio set for transmitting and receiving work. The lifeboats are handled by six electric winches and stowed under mechanical davits.

Fire screen bulkheads are to be built in the passenger quarters to form small compartments for confining any fire that might start. These bulkheads are to be built of wood covered with asbestos and galvanized iron.

The safety of the vessel is further secured by fifteen hydraulically operated watertight doors controlled from the bridge. Any door once closed from the bridge can be opened locally but will immediately close.

For supplying electric current to the various auxiliaries and for lighting, four 300 K.W. generating sets are provided. Steam turbines of 3600 R.P.M. are geared to the generators which deliver their normal output at 1200 R.P.M. Direct current is supplied at 240 volts. In addition, there is located on the shelter deck aft a Diesel engine driven generator of 25 K.W. capacity as an auxiliary set. (*Continued on page 142*)

Some Unusual Marine Accidents

Three accidents that were unusual in their occurrence, their results, and in the unique engineering problems arising in their repair

By EVERS BURTNER, '15

Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology

THE romance of the sea has always interested nations whether they are sea-faring or not. This undoubtedly is due partly to the fact that vessels at sea occasionally disappear leaving no trace behind. Probably the airplane and airship will assume the same "air" of romance when they make trans-ocean flights and thus now and then become prey to Davy Jones' Locker. The story of two negroes discussing ocean versus train travel illustrates this quite well.

"Sambo," said Dinah, "I reckon I won't be gwine with yo in dat steamboat to Savannah; I sho will take de train." "How's dat, Dinah?" "Well, Sambo, if you're in a train smash up, dere yo is; but if yo blow up in a steamboat, where is yo?"

With all the marine casualties, the rate of loss of passenger lives on shipboard per hundred thousand carried corresponds roughly with the number killed in railroad travel. In fact, such lines as the Cunard, the Merchants and Miners Transportation Company, concerns in business fifty years or more, had never lost a passenger's life until recently. While it is too much to hope that the American public will be as nautically inclined as the British or our colonial ancestors scattered along the Atlantic Coast, the problem of America's merchant marine is better understood now than before the War. Furthermore this interest will increase if American shipping can carry a reasonable part, not necessarily half, of her foreign trade. We should remember that if we protect our manufacturer and farmer by a tariff, the ship owner and builder deserve some protection to allow for the greater labor cost here.

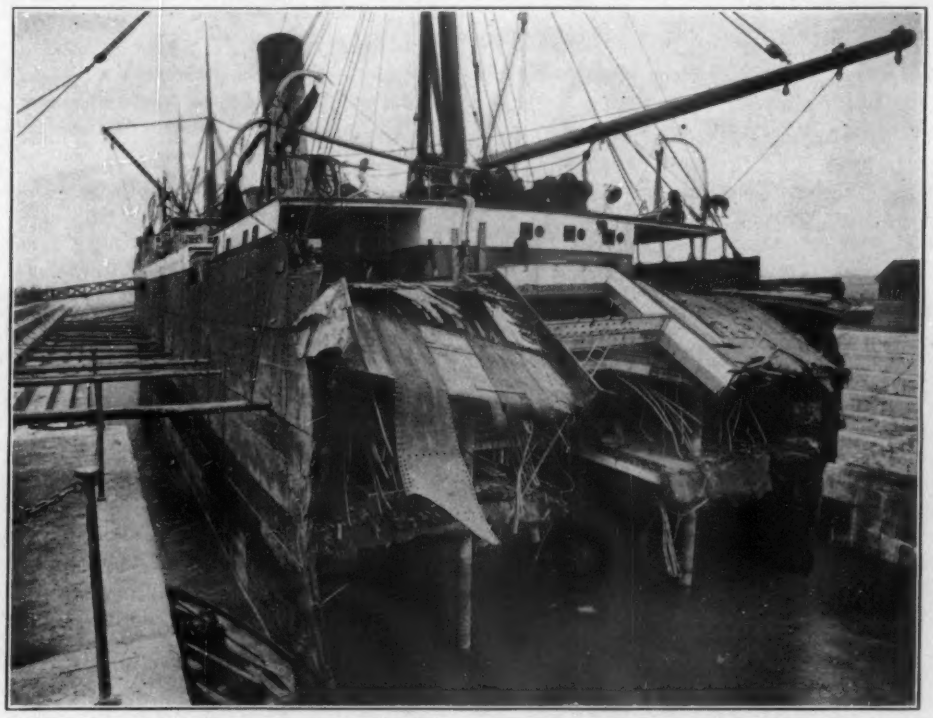
People flock at once out of curiosity to examine the after results of an automobile collision. The resultant damage from the collision of two vessels is even more interesting, due to the far greater masses and momenta involved. Usually the public must be content to view the marine damage second hand, as through the newspaper column or by pictures.

Long before the advent of the automobile and our numerous traffic laws, the international law of the sea required that the vessel on the starboard side of another should keep out of the way. Thus our automobile laws have consciously or unconsciously adopted the same regulation. Naturally, at sea the overtaking steamship must keep clear of the vessel overtaken. The whistle as a signal is used not only to indicate the intended course of a steam vessel approaching another, but it also serves as a warning in fog. In the case of a sailing vessel a manually operated fog horn is employed. Since the range of such a horn is naturally limited, and the wind during a fog is light, more than one sluggishly moving sailing vessel has been cut down by its steel sister steamship.

While this forms a digression, the marine insurance policy may be briefly explained. The policy assumes that the owner uses due diligence in the selection of master, officers, and the upkeep of vessel so that on the start of a voyage the vessel is in good care and in seaworthy condition. The underwriter and owner have a neutral party, the Registration Society (in case of the ship), which will determine whether the vessel is in seaworthy condition. While the yearly premium on a marine hull policy is only about 5 per cent of the vessel's value, this, unlike the ordinary automobile insurance, covers not only fire and foundering but also collision damage, whether your ship was in fault or not. Even accidents to the vessel's machinery which amount to over a certain small sum are likewise repaired by the insurance company. Naturally, the above presupposes that the owner, crew, and insurer are honest, and in practice the dishonest are eliminated.

Since steel ships must have a high carrying-capacity and cannot be designed for battering-rams, collision damage is usually local. Thus a vessel striking another will be damaged forward. To reduce danger to themselves from such accidents all ships (sail and steam) are fitted in the fore part with a water-tight athwartship partition or collision bulkhead. Since the owner wants to carry the maximum cargo, he is anxious to move this bulkhead as far forward as possible, thereby increasing the size of his cargo holds. Hence Government and other restrictions require that this bulkhead be located a fair distance aft of bow — about 1/20 or more of the ship's length.

The vessel that is struck at any point save in way of the fore peak will only be prevented from foundering by the capacity of her pumping equipment, the buoyant effect of her cargo, or the great number of her water-tight compartments. While the pumping capacity of a steamship is relatively great, it can cope with only a small hole. The buoyant effect of the cargo cannot be definitely counted on as the



A "HEADLESS HORSEMAN" COMES HOME

The S. S. Suevic as it appeared in the Southampton dry dock.

vessel may sail empty. The real "factor of safety" against foundering is dependent on the closeness of spacing of the athwartship bulkheads. Vessels which will remain afloat after one compartment is flooded are known as one-compartment ships. Some large-size steamers will still float even with two or three compartments open to the sea.

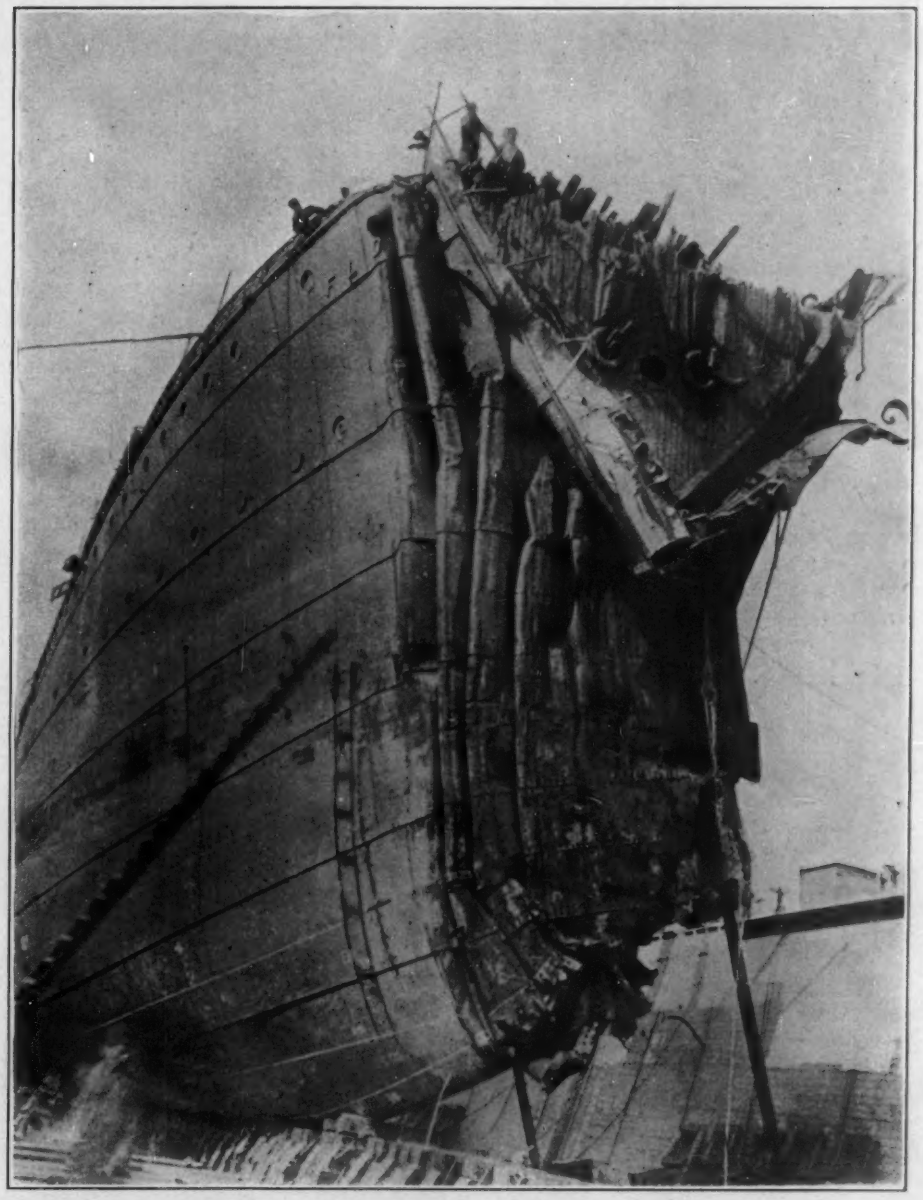
The collision of the steamships *Florida* and *Republic* in 1909 resulted in a very curious bow damage to the *Florida*. During a dense fog off Nantucket Lightship, the tramp steamer *Florida* struck the liner *Republic* squarely amidships and in way of the machinery space. The *Republic*, which was 550 feet long, would have remained afloat if several important bulkheads had not failed. Since that time the requirements for the strength of such bulkheads have been increased, and similar disasters we trust will not be so frequent. Fortunately, fogs are not accompanied by stormy weather, so the passengers were readily transferred to other ships from the slowly sinking *Republic*.

Reference to the picture of the bow of the *Florida* shows that her steel sides folded up in concertina fashion as far as the fore-peak bulkhead, while the wood-sheathed steel forecastle deck broke sharply off and folded over the other structure. This form of damage is explained by considering that the *Florida's* deck at the bow was several feet higher than the strength deck of the *Republic*. Thus in the collision the *Florida's* sides were crumpled up by the lower decks of the *Republic*, while the *Florida's* upper deck pierced the comparatively weak super-structure of the *Republic*, meeting little resistance. After the ships separated, the *Florida's* deck, now unsupported by the crumpled sides, folded down over the other structure. The fact that the sides telescoped like a kodak bellows is due to the local support offered the plating by the transverse frames spaced every two feet.

In the above case both vessels were seriously damaged. This would be expected, since the weights of the *Republic* and *Florida* were approximately 25,000 and 8000 tons respectively and the *Florida* struck the *Republic*. If the vessels in a collision are roughly the same size, both, as a rule, are badly damaged. Also the vessel that is struck in general suffers the most.

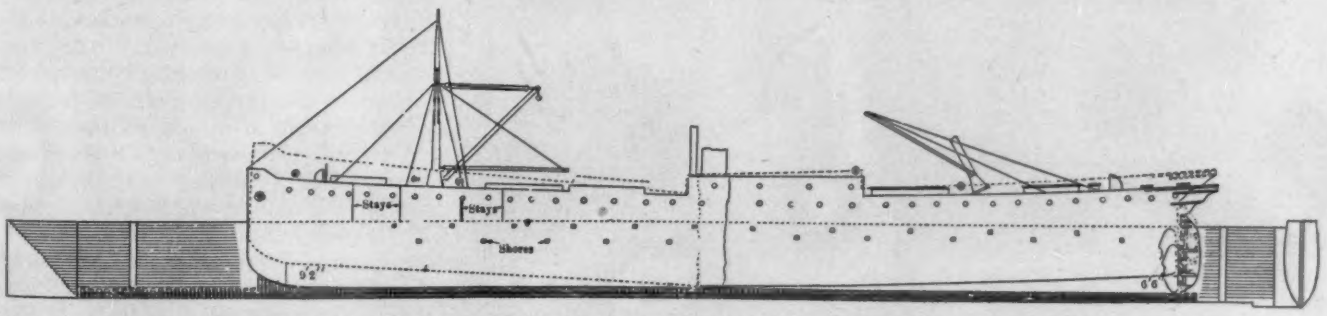
Since the fore-peak bulkhead of the *Florida* held tight, the vessel steamed to New York under her own power. As a rule, the time element is considered in awarding repair work; thus a vessel of the *Florida's* size would have a demurrage charge of over $1000 per day. The Morse Dry Dock and Repair Company of Brooklyn rebuilt the bow in the short time of twenty-four days

(*Continued on page 148*)



NO MORE MUSIC FROM THIS "ACCORDION"

The S. S. Florida in dry dock after collision with the Republic.



BUCKLING OF THE CURACO BY A T.N.T. EXPLOSION IN HALIFAX HARBOR

The Curaco in dry dock — dotted lines show position after explosion; heavy lines after repair.

The Trend of Modern American Architecture

The tendencies in architecture in the United States considered as an expression of the economic and scientific development of the country

By ROBERT M. BLACKALL, '17
Of Blackall and Elwell, Architects, Boston

A GREAT deal has been written and a great deal is being said as to whether there is being developed in this country or anywhere else in the world at the present time a new style of architecture.

France and Germany show many manifestations of an attempt to devise a new architecture, with saddening results. The exposition in Paris is a horrible example.

I am not going to attempt to prove whether or not any style is being developed in this country, but I should like to point out certain tendencies and certain factors that I feel are having a very strong effect on the trend of modern architecture and on the architects of this country and their work. These factors are working slowly, without any blare of trumpets or any exhibitions, but nevertheless are working just as sure, in my opinion. The results, however, cannot be predicted, nor can they point to any style at present. These forces may be divided into the following divisions:

(a) Social life of the average citizen of this country;

(b) Economic life in and economic development of the United States;

(c) The building laws of our cities;

(d) The manner by which an architectural education and architectural tradition are acquired.

None of these factors are acting alone; all are contributing together to shape the thoughts and desires of the individual, and so his architecture.

Architecture expresses the life and the environment of the people who use the buildings. As each generation comes and goes, its needs and wants are expressed in its buildings. It is always necessary, in order to appreciate a period of architecture, to know the social and economic history of that period.

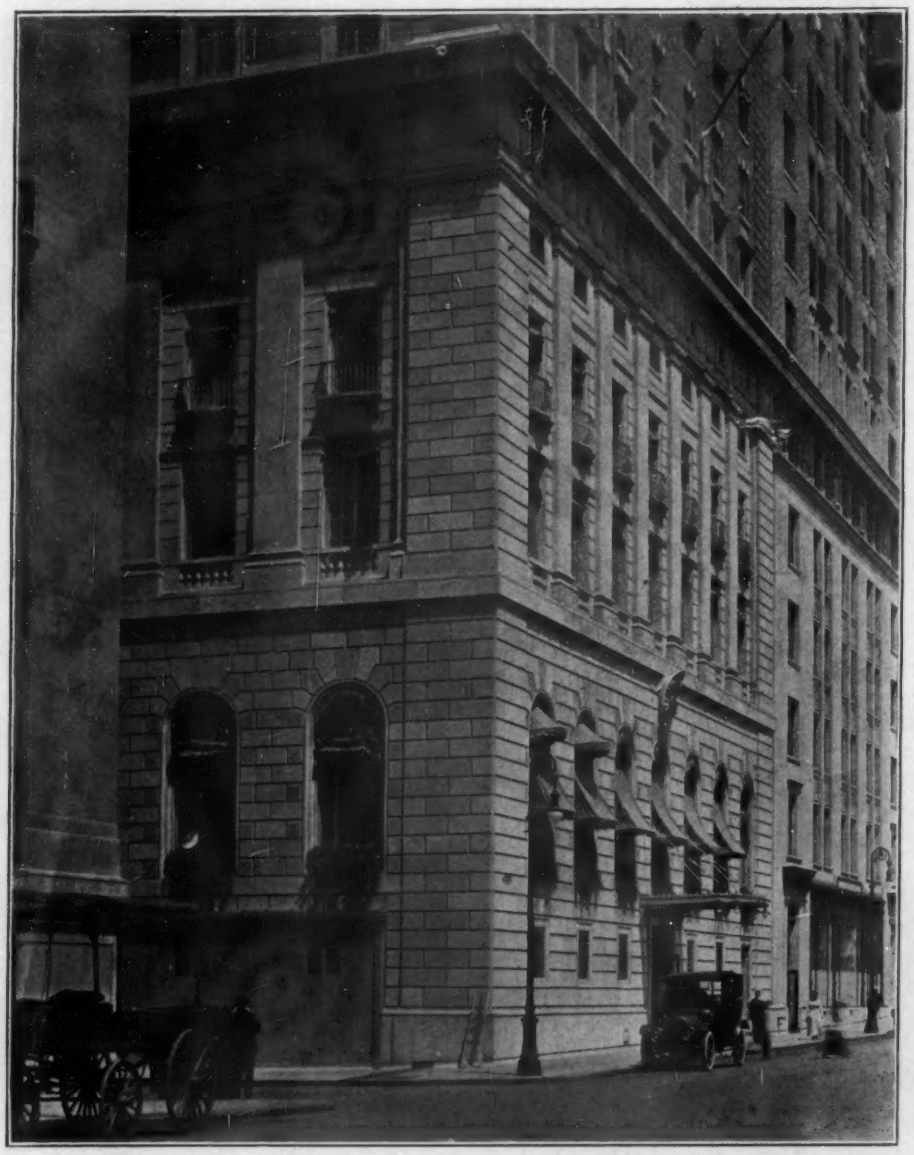
Probably never before in the history of the world have the middle and lower class of people had as much as they have in the United States at the present time. It is only necessary to compare the palaces and royal homes of Europe with the average American's home today. A small seven-room house will have hardwood floors, open fireplace, steam heat, good plumbing, a radio that can tune in to any portion of the world, electric lights, electric heater, and telephone that gives communication to all parts of the country. No royal personage nor emperor, not even Cæsar or Augustus, ever had the power and wealth at his command as has the average home.

With the advent of the automobile the garage connected to every home, or to every building, has come or is coming, just as the stable used to be connected with the home or public building in the early development of this country.

It is nothing to ride thirty or forty miles to some country inn to have supper or seek some form of entertainment. Did the Romans, at the height of their splendor, ever have the advantages that are available today? In Massachusetts every family on the average owns one automobile at the present time.

One more social tendency is the closer housing, both for business and for homes. This brings a smaller room and the present-day apartment. I believe that the present-day office building and the present-day apartment have, in scale and in plan, no precedent in any style or period of architecture. Certainly the reaction to this change in social life is causing a change in the type of buildings which are being built.

Closely allied to the social life is the economic development of the country. If there is anything in modern Americanism that predominates it is speed. We rush from the ground to the top



THE YALE CLUB, NEW YORK CITY

An adoption of Florentine architecture to a modern American city building. James Gamble Rogers, Architect.

of a forty-story office building. We rush through the subways. We rush to the train in the morning. We go through the streets and dodge the automobiles, and everywhere we turn is hurry. The pressure in this country on the average citizen today is tremendous. The business man thinks nothing of going one hundred or two hundred miles to transact business. Even in the last sixty years the change has been tremendous. Steel construction, elevators, electricity, the modern office building, subways, the automobile, and now the aeroplane, have come to this country and to the world. Certainly these are conditions not comparable to any other period in history, and so in architecture, that I know of. There has probably been more advance in science in the last seventy-five years than in any other seventy-five years that the world has ever known.

This country prides itself on its democracy. We hear of self-made men; our Constitution states that all men are created equal. In England a shop will pride itself on being "Purveyor to the King," but Ford advertises a "flivver in every home." A breakfast food will state "a million consumers." In other words, this country is a land of the middle class, where every man has an opportunity and is looking forward to being more than his parent and hoping his sons will be greater than he.

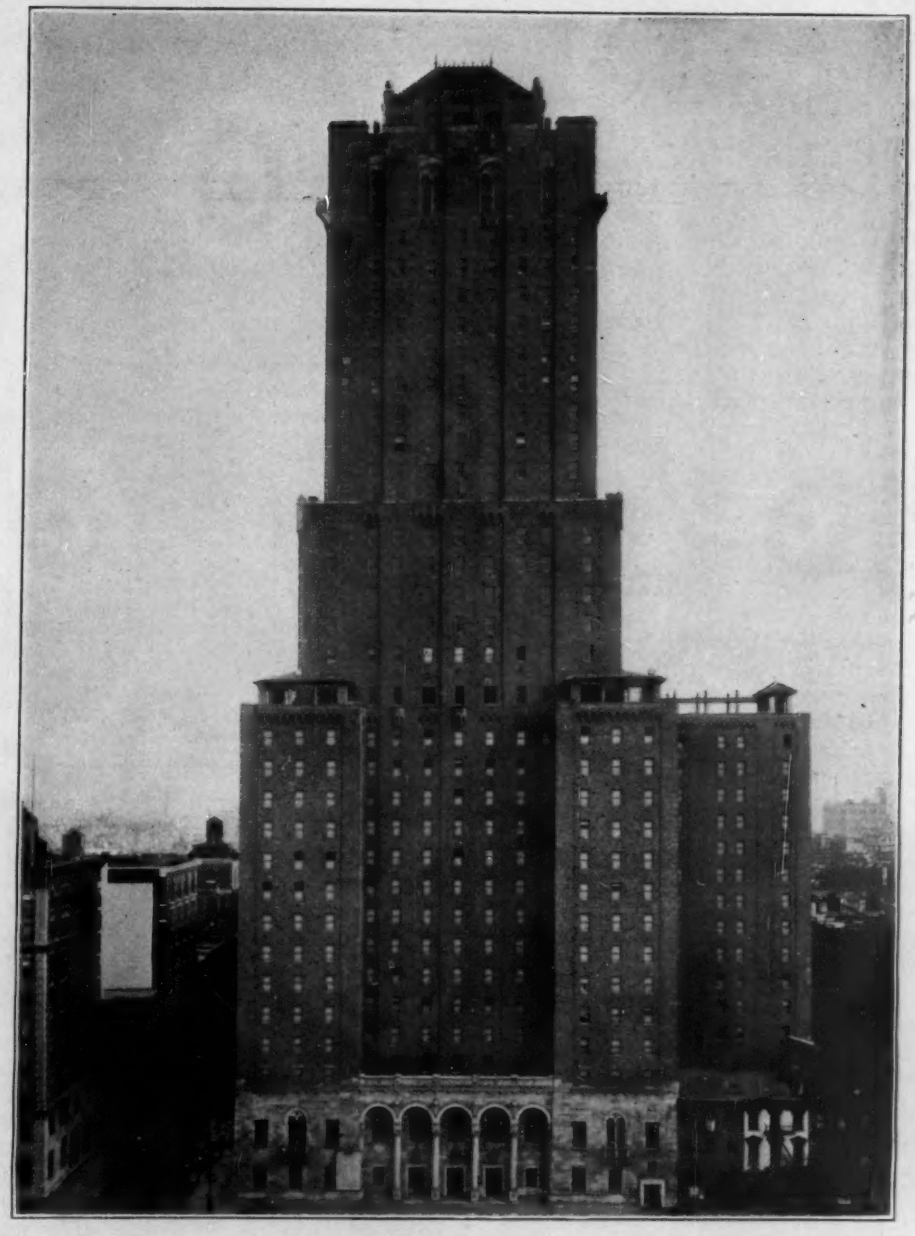
With this speed and development has come a great deal of wealth. One need only go to some modern hotel, or to a bank building, like the Bowery Savings Bank in New York, to see the wealth of material placed in these buildings. With this growth in wealth and capitalism have grown the Labor Unions, and through these Labor Unions have grown labor banks and labor organizations tending to consolidate the people and to raise them from the hard conditions of labor to which the middle man in this world has been always subject. With the introduction of profit-sharing schemes the employee is becoming a capitalist, and certain economic authorities claim that this is bringing about an even greater revolution than has been experienced at the present time in the Labor movement.

Surely these economic changes are affecting our buildings, our thoughts, and our desires, and so, architecture in this country.

With such a social life and economic development in this country it has been necessary in most of the cities to frame and pass building laws. These laws deal with the strength of materials and with set-backs and heights of rooms. Streets are being widened in Boston, tall buildings have set-backs in New York. Size of cornice, width of court in apartment houses, rise and tread of stairway, regulation of heating and ventilation, all have been passed and bind the architect to sizes and proportions in his design. This phase of the development of the country probably affects more than anything else the visible aspect of the building. For instance, a client will ask for a building in the style of the Italian Renaissance. During the Italian Renaissance it was necessary to have small openings and thick walls, such as the palaces of Florence have, for protection, as the social and economic life was far different from that at the present time. So, when an architect lays out a building in the Italian Renaissance style, under the present social and economic conditions, with the building laws governing the size of cornice, the width of court, the height of room, it is difficult, when the building is completed, to have anything but detailed mouldings in the original style. For instance, we lay out a room which, in the Italian Renaissance, may be 12 to 14 feet high, but the modern law will allow 8 feet, 6 inches, so we lower the window heights; but the law requires certain area of window, so we increase the window. I do not think that there is much left of the original style when we have complied with all conditions, and I am frank to call it modern American architecture. Is there any precedent for the Hotel Shelton in New York or the Woolworth Building in the history of architecture of the past?

One further factor that enters into the architecture, and perhaps more so in the visible part than in the structural

(*Continued on page 138*)



THE SHELTON HOTEL, NEW YORK CITY

A type of modern American architecture. Arthur Loomis Harmon, Architect.

Inspection Methods

The maintenance of standards of measurements in manufacturing processes

By EARL BUCKINGHAM

Associate Professor of Engineering Standards and Measurements, Massachusetts Institute of Technology

Technique of measurements, or skill in the art of measuring, is an important part of every engineer's equipment. First essential to acquire this skill is a full understanding of the purpose and nature of measurement. The object of this series of short papers is to present briefly some of the fundamentals of this subject. The first article dealt with the measurements themselves and the fundamental units of time, space, and mass. The second article treated the application of these fundamental units in defining specific engineering standards. In the third and last article of the series, in this issue, Mr. Buckingham deals with the problem of testing or actual measurement, as applied to manufacturing in order to insure the maintenance of these specific engineering standards.

INSPECTION implies measurement, either of size, performance, or quality. Measurement is a fundamental manufacturing process whose importance increases rapidly as the volume of production increases. Inspection methods should receive the same attention that other production methods receive. In the final analysis, the simplest methods that are effective are the best methods.

In general, measurement or inspection should be employed as a preventative and not as a cure. Inspection methods which will prevent faulty parts from being produced are of far more value than those which merely sort the good parts from the bad. The ideal inspection and production system would be to have tools and equipment of such proven reliability that periodic tests of this equipment alone would insure correct results. This is the end toward which we should always strive. The more nearly any production process approaches this condition, the less the attention that is needed in watching the product itself. The measurement of the tools and other manufacturing equipment should always receive primary attention. Too often, however, inspection is considered as a sorting process only. Despite every precaution, some faulty parts appear. Some sorting is therefore necessary, but this is a minor and not the major duty of inspection.

Shop measurements may be roughly divided into two general classes — direct and comparative. A direct measurement is one where the attempt is made to determine the actual, or abstract, size.

A comparative measurement is one where the attempt is made to determine the difference in size between similar or mating surfaces. In general, a comparative measurement is much easier to make than a direct one. With equal care and skill, a comparative measurement will always be more accurate than a direct one. Furthermore, differences in size too small to be detected by ordinary direct measurements are readily detected by ordinary comparative ones. For example, if two ply gauges within one quarter of a tenth of a thousandth of an inch of the same size were given to several skilled workmen to measure with micrometers, they would probably report them to be of identical size, but their measured values would probably vary one or two tenths of a thousandth of an inch. These same workmen, however, comparing the two gauges with ordinary calipers, will invariably pick out the same larger and smaller one, although the actual difference in size is too small for them actually to measure. Thus when uniformity is essential on any critical dimension of the product, a physical standard or master gauge of the size desired is always the simplest and most effective means of maintaining this uniformity.

No measurement of a physical quantity is ever correct in an absolute sense. Accuracy is a relative term. In machine-shop practice a definite dimension may be specified. When reproduced in metal we may never get that exact dimension, no matter how many similar parts we make. What we obtain is a more or less accurate approach to the specified size. Thus on a drawing the dimensions are constants, but in metal the sizes of the several surfaces are variables. If we keep this fact in mind, it will do much to clarify the subject of proper dimensioning.

It may seem as though the matter of dimensioning drawings has little to do with inspection methods, but a little thought will show that the two problems are intimately connected. The drawings and specifications for the product may be considered as laws which the inspection methods should equitably enforce. If these laws are just, reasonable, and clear, the problem of enforcing them is simple. If, however, they are arbitrary or ambiguous or inconsistent, it often proves impossible to enforce them.

Thus the logical first step toward developing effective and simple inspection methods is to provide the proper drawings and specifications for the product. This is no easy task. To dimension such drawings properly and to establish tolerances which can be met readily in production, and also insure a product which will function properly, requires more thought and experience than any other task of production.

When the positions of the dimensions are governed more by the convenience of the draftsman than by the essential interrelation of the surfaces dimensioned, either the dimensions must be ignored or unnecessary expense in production will be entailed. If all measurements were absolute, it would make little difference, perhaps, how the various positions were determined. But as they are not absolute, this matter of what measurements are made becomes of vital importance. If two measurements are made where only one is required, double the variation or tolerance is necessary. Or if the amount of variation is definitely limited, it would require holding two dimensions to one-half the tolerance otherwise available. Thus, when the proper functioning of the surfaces in question requires a definite degree of accuracy between certain essential surfaces whose positions are thus indirectly controlled, it results in the necessity of a far higher degree of accuracy — which is always expensive — in the machining and measuring of several supplementary surfaces than is actually required between the two essential surfaces. This increased degree of accuracy will be in direct proportion to the number of supplementary measurements made to control the essential dimension, and the cost of maintaining these supplementary surfaces to this unnecessary degree of accuracy thus demanded will increase far more rapidly.

One fact should always be kept in mind. A high degree of accuracy is very expensive and does not always serve any useful purpose. Any surface should be held to that degree of accuracy truly required, and no closer. Every functional surface of a mechanism has more or less definite limits of size within which it will operate properly. In some cases the extent of the permissible variations is very small; in many other cases it is relatively large. No useful purpose is served by arbitrarily holding all variations to extremely small amounts regardless of the conditions to be met. The object of manufacturing is not to see how closely certain sizes can be held, but rather to produce useful commodities as economically as possible.

The whole problem of permissible variations, or tolerances, is a very vital one, involving not only the manufactured product itself, but also the tools and other equipment used to produce

(*Continued on page 136*)

Finding an Anti-knock Material

An explanation of the cause of the knock in internal combustion engines and the story of the discovery of its preventive, tetraethyl lead

By THOMAS MIDGLEY, JR.
Vice-President of the Ethyl Gas Corporation, Dayton, Ohio

THE early internal combustion engines, like the early steam engines, were very useful tools even though they converted but a small amount of the heat energy initially in the fuel into useful mechanical work. This conversion of one form of energy into another has received an enormous amount of attention by many of the ablest scientific minds.

The internal combustion engine did not require the amount of fundamental research in thermodynamics that the steam engine had, as this work had already been done when the internal combustion engine made its appearance, and it was only necessary to translate the language of the steam engine into the language of the internal combustion engine in order to know what should be done with the internal combustion engine to increase its efficiency. Outstanding among other rather obvious improvements was the use of higher compression ratios, and to those not versed in the art of the internal combustion engine this appeared to be a very simple thing to do, merely requiring a mechanical design for reducing the clearance volume in the combustion chamber when the piston was at top dead center. Practical application did not bear out theoretical prediction. As is often the case with new developments, a factor greatly influencing the final result remained unknown until the experiment was tried. In this case the unknown factor that made its appearance with any attempt to increase thermal efficiency by increased compression ratio was the well-known "knock."

Many years were required after the discovery of this phenomenon before it was understood in the least, and at present our knowledge of the cause of "knocking" is still far from perfect. "Detonation" has come into popular use in discussions of the nature of knocking. Detonation implies that the burning gases are responsible for the noise instead of the hammering together of loose metal parts.

I remember in 1902 my first experience with the then-called "knocking." I was learning to drive, under my father's direction, an early variety of automobile containing a two-cylinder horizontally opposed motor. Approaching a slight grade, which in the automobile language of the times was a hill, the motor seemed to become aware of the fact by some subconscious process, and emitted a most startling and frightening noise, sounding as though some evil spirit underneath the slanting hood was using a sledge-hammer with the foul intent of further reducing the motor's standing in the junk league. Fearfully, I asked my father what was taking place, and was informed that the spark was too far advanced, causing the gases to explode before the piston reached top dead center, and that this caused the connecting-rod bushings to pound against the crankshaft, and if I would retard the spark (this actually having been done already by a somewhat impatiently guiding paternal hand), I would find that this disturbance would cease. It did.

The lessons learned in childhood are usually accepted as axiomatic as the mind grows more mature, and my own case was merely typical of the entire field of gas engineering. The fathers of the industry gave to the youngsters similar explanations of knocking, and the youngsters accepted them as requiring no proof.

During the past ten years our knowledge of the cause of knocking has been considerably enlarged, due to the work of many investigators both in this country and in England; so that now we formulate the following picture: The spark ignites the combustion mixture and a portion of it burns in a normal, well-behaved manner. Then suddenly the balance of it decides to burn at an abnormally high rate of speed (presumably the velocity of sound). This produces a high pressure wave traveling at this velocity and with a maximum pressure far in excess of the highest pressure that would be developed by the gases were their combustion normal. This pressure wave strikes the side of the cylinder head and causes the noise that all motor operators are familiar with. Were this all that took place, either sound-proof hoods or ear tabs would solve the difficulty; but either due to the nature of this abnormal combustion or due to the rebounding of the higher pressure wave through the hot gases, an abnormal quantity of heat passes to the walls of the cylinder head and piston top as radiant energy. This heat loss negatives the gains in thermal efficiency which should accompany the increased compression ratios.

Probably when the rising generations of internal combustion engineers have assumed the position of the fathers of the profession, they will likewise be in possession of sufficient knowledge to look back to these present-day explanations and remark upon the colossal and dogmatic ignorance of their forebears.

It has been my good fortune to be associated with a study of this phenomenon. The technical side of this investigation has been published in many of the engineering and scientific journals in a series of papers dating from 1918 to the present time — the authorship varying with regard to the particular research reported. An accurate résumé of this work from a technical standpoint would be far too lengthy and tedious to include in the present article, but there was a human side to this research which plays no part in a scientific paper, and which may be of interest to investigators of similar subjects.

The primary factor that led us eventually to the discovery of a material — namely, tetraethyl lead — which was practical and commercial for making possible the use of higher compression ratios, thereby increasing thermal efficiencies, was not any superintelligence, super-hard work, or superanything that the average research worker should pride himself in possessing. We do not disclaim our own reasonable share of human intelligence, nor did we spend all of our time fishing and playing golf; but had it not been for the guiding hand of the Goddess of Luck, this research certainly would have been abandoned in its infancy.

Early in the work we had a theory which, like the famous theory of Christopher Columbus that he could uninterruptedly sail westward from Spain and arrive at India, was founded on some observed facts, but was quite wrong though leading to a valuable discovery. I will not burden you with the details of this theory; whilst it was wrong, it must have been good, for it led us to discover new facts, and has since been proposed by many of the ablest minds whom we have called on to help us in our work.

The theory predicted that if we colored the fuel it would stop the knocking. We went to the chemist in charge of the stock room and asked him for some oil soluble dyes. He replied he had no oil soluble dyes (piece of luck No. 1), but had water soluble dyes, and what did we want to dye, anyway. When we told him we wanted to dye gasoline he said, "Try this," and reached for the first bottle at hand. It proved to be a bottle of crystalline iodine. (There were 2000 bottles in the stock room, and only one bottle contained an anti-knock material; as we now know, this was the bottle of

(*Continued on page 140*)

The Pictorial Section

An interesting description of the pictures in the marine section

IN this issue we are showing some of the engineering accomplishments which contribute to the comfort, safety, and economy of present ships. Figures 1 and 2 show the assembling of the low-pressure Parsons turbine for the *S. S. Olympic* of the White Star Line. This turbine is very large, as can be seen from the photographs, and develops about 16,000 horsepower. It operates on exhaust steam from the liner's reciprocating engines at about 9 pounds absolute and exhausts into a condenser at 1 pound absolute. Using the exhaust steam from the reciprocating engines results in a very high overall efficiency. The *Olympic* uses just this one turbine, driving the center propeller direct at 165 r.p.m. The two reciprocating engines from which the turbine draws its steam are used to drive the port and starboard screws. The advantage of this arrangement lies in the high efficiency gained by utilization in the turbine of the low-pressure exhaust steam, while the two reciprocating engines on the outside screws give the maximum maneuverability. Direct-drive turbines are not so desirable in maneuvering. However, this arrangement is no longer considered for new vessels. The advent of the efficient high-speed geared turbine resulted in a smaller-sized unit and thus reduced the expansion difficulties inherent in the large direct-drive turbine. The reversing turbine also is reduced in size, hence is more reliable than the old type. The rotor seen suspended in the air in Figure 2 weighs 130 tons. Its shaft is 20 inches in diameter. The complete turbine, assembled, weighs 420 tons.

With our large ships of today, the problem of rudder control is one of the most difficult facing the marine engineer. Great strides have been made within the past few years in this direction. Figures 3, 9, 10, and 12 show the various components of the steering mechanism and control of different vessels. Figure 3 shows the steering engine on the *S. S. Olympic*. This engine is a simple steam engine which is controlled by the wheel in the pilot house.

The steering wheel operates hydraulic pistons which communicate their motion through pipe lines to a master valve on the steering engine. This valve so controls the admission of steam to the steering engine that the motion of the latter follows the steering wheel exactly. Nearly all the high-class ships in service use this particular system, which is known as the Telemotor System. The engine operates the tiller through gearing and a large quadrant. Figure 12 shows the rudder quadrant and its connection to the tiller above it on the *S. S. Leviathan* of the United States Lines. The picture gives an excellent impression of the immensity of this unit. Elaborate provisions are made in the design to absorb all shocks from rough seas as well as the initial acceleration of the steering engine, as any failure of this mechanism at sea would prove disastrous. Two steering engines are provided on most high-class passenger ships to insure dependability in this most vital part of ship control.

Within very recent times, the gyroscope has been developed as a further aid to the navigator. Figure 9 shows the master Sperry gyroscope compass which has replaced the magnetic compass on many ships as the principal navigating compass. It consists of a heavy wheel running at a very high rate of speed and arranged so that it will tend to line itself up, by reason of the gyroscopic action, with the meridian, thus acting as a compass.

The famous "Metal Mike," or automatic pilot, is shown in Figure 10. The box at the left of the wheel replaces a quartermaster as pilot. At the top is a "repeater" compass card operated from the ship's master compass. Inside is an electric motor operated through electrical contacts by the gyrocompass and rudder. This motor is geared to the steering wheel, and so keeps the ship on any desired course.

Another application of the gyroscope, although still in the experimental stage, is the stabilizer to obviate the effects of rough seas. The device is shown in Figure 11 designed for service on a cruiser. For a 10,000-ton ship, a stabilizing unit of this type weighs approximately 30 tons. It affects the transverse stability of the craft to a remarkable degree; but in some cases it was found that when rolling was checked the ship was set to pitching violently. It may be that in time this will be perfected and used on our ocean liners.

At the left of Figure 5 is shown a portion of the line shafting and one of the line-shaft bearings of the Cunard Liner *Laconia*. The line shafting is used to transmit the power from the turbine reduction gears to the propeller. In the center and to the right are two of the turbo-generator sets for generating electricity for all shipboard uses.

Figure 4 shows a glimpse of the generator room of the *S. S. Laconia* of the Cunard Anchor Line. One may observe the turbo-generators down below for furnishing light and power, as well as the control panel for the distribution of this power. Electricity finds many uses on board ship today, and the electrical equipment is very complicated and important.

Formerly the sole fuel used at sea was coal, which was difficult to handle and resulted in general inefficiency and dirt on the decks due to the dust. Recently oil has been used as a fuel with very satisfactory results. Figure 6 shows some of the fuel oil pumps and the bottoms of the heaters used on the *Olympic*. The fuel oil is pumped from the settling tank through the heaters to the furnace nozzles. In the steam-operated heaters the temperature is raised to as high as 300° Fahrenheit. The oil is sprayed from the nozzles at a pressure of from 80 to 200 pounds imparted by the pumps.

Figure 7 shows the steam windlass on the *S. S. Leviathan* for raising and lowering the anchors. This picture gives one an idea of the great size of the equipment needed for handling the anchors. The chain is of the stud link form which reduces the tendency to kink.

There is nothing more dreaded than fire at sea, and great pains have been taken and a great deal of ingenuity has been displayed in some of the devices for detecting and extinguishing fire on board ship. Figure 8 shows the fire-detector indicating apparatus on board the *Leviathan*. A tube communicating with each of the compartments of the ship has a draft of air drawn through it from that compartment. If any smoke is in the air, it interrupts a beam of light and causes the indicator shown in the pilot house to operate. A valve can then be operated to flood the compartment indicated with foamite or carbon dioxide, and close the fire-proof doors, directly from the bridge. The major part of this work has been done by the Walter Kidd Company of New York.

This account gives only a glimpse of today's marine engineering and some of its problems. The trans-Atlantic liner is a veritable city, with its large stores of food kept in refrigerating compartments, its kitchens and other necessities for the comfort of passengers. There has to be provision for making and carrying fresh water and disposing of sewage. All of these problems, as well as those connected with the expeditious loading and unloading of cargo and stores, confront the marine engineer and naval architect. Great progress has been made during the past, and the outlook for future development is encouraging.

A. K. STRICKER, JR.

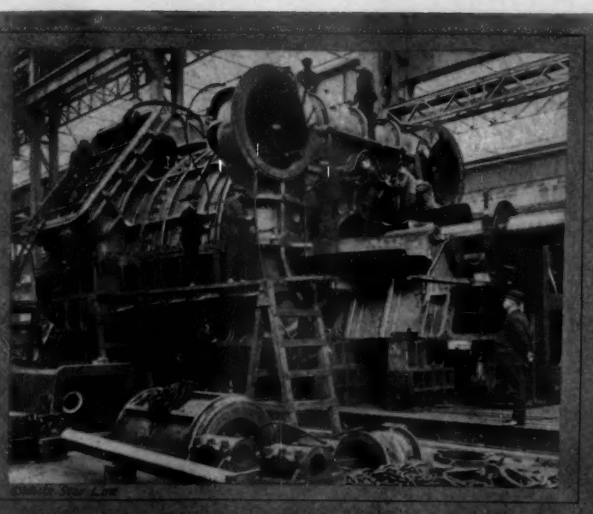


FIG 1 16000 H.P. TURBINE CASING
S.S. OLYMPIC

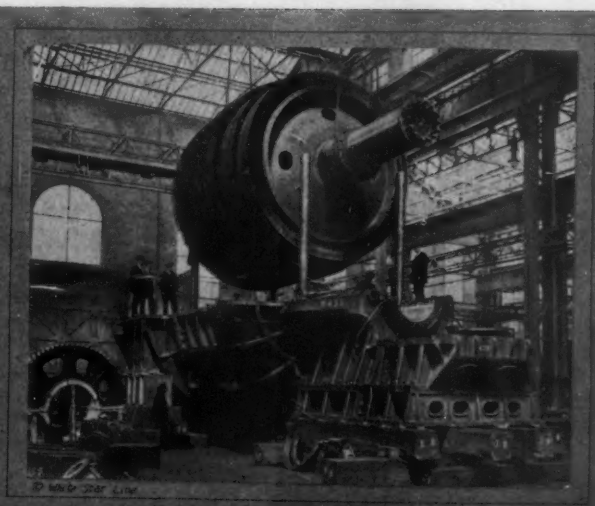


FIG 2 ROTOR OF L.P. TURBINE
S.S. OLYMPIC

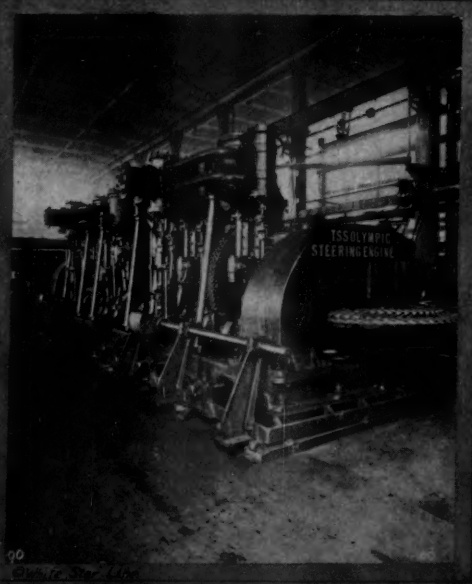


FIG 3 STEAM STEERING ENGINES
S.S. OLYMPIC

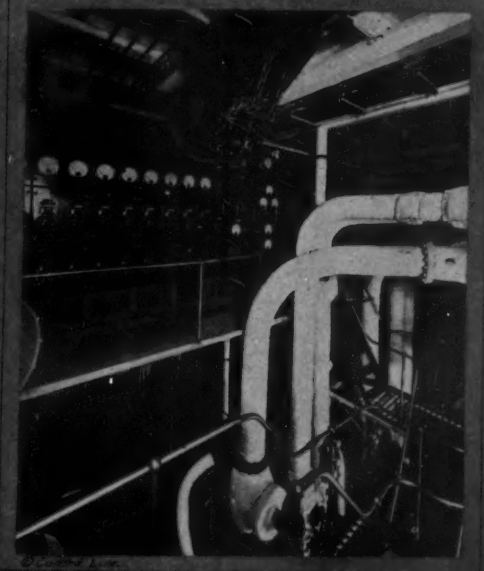


FIG 4 ELECTRIC DISTRIBUTION PANEL
S.S. LACONIA

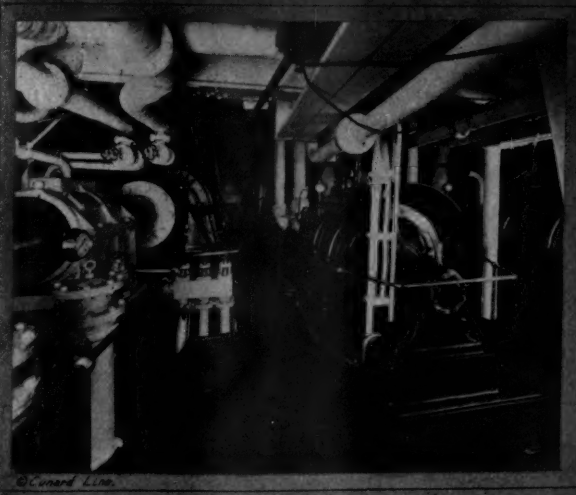


FIG 5 MAIN LINE SHAFT AND BEARING-LEFT
GENERATOR SETS-RIGHT-S.S. LACONIA

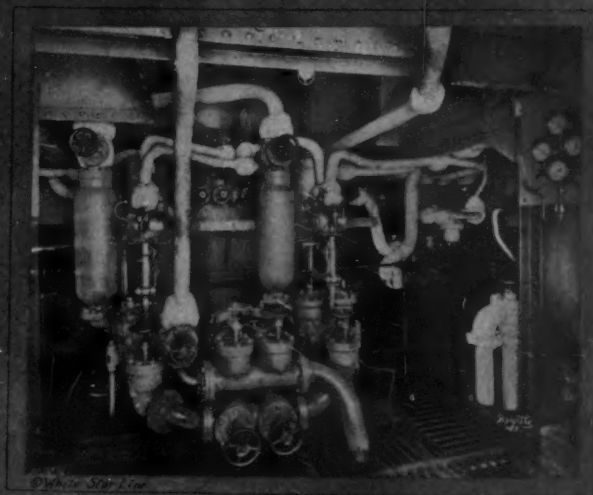


FIG 6 FUEL OIL PUMPS AND HEATERS
S.S. OLYMPIC

FIG. 7 ANCHOR WINDLASS
S.S. LEVIATHAN

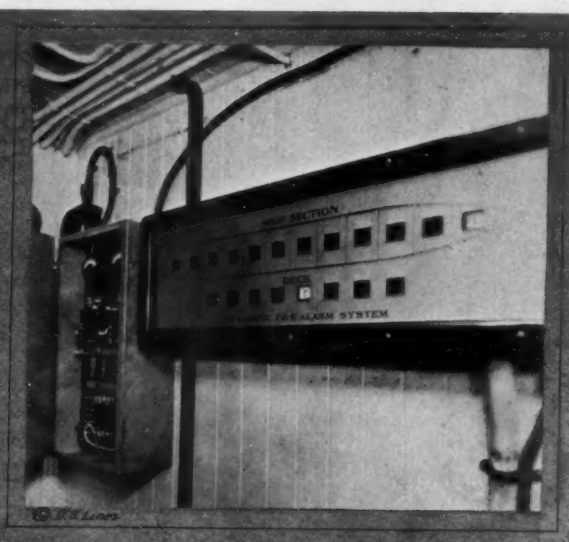


FIG. 8 AUTOMATIC FIRE INDICATOR
S.S. LEVIATHAN

FIG. 9 GYRO MASTER COMPASS
CONTROLS OTHER COMPASSES ON BOARD

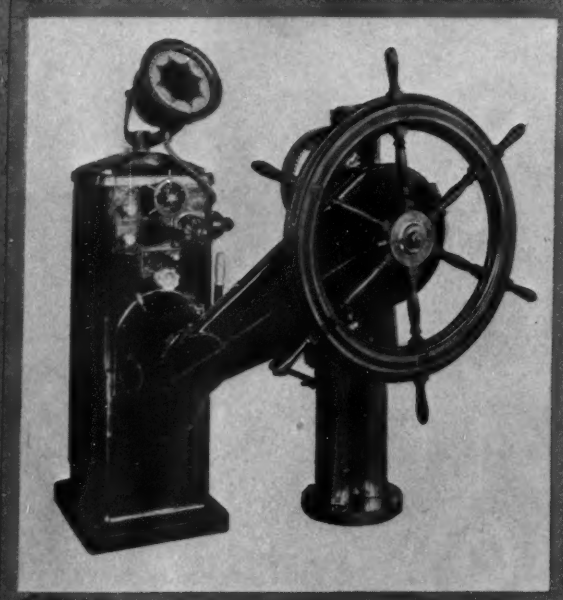


FIG. 10 "METAL MIKE"
GYROSCOPE CONTROLLED STEERING WHEEL

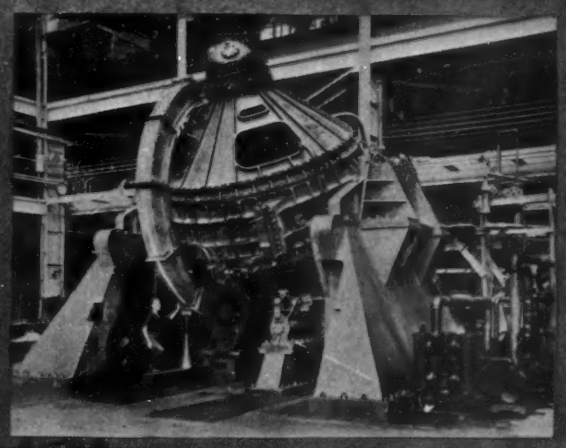


FIG. 11 CRUISER GYRO-STABILIZER
BATTLE CRUISER TYPE

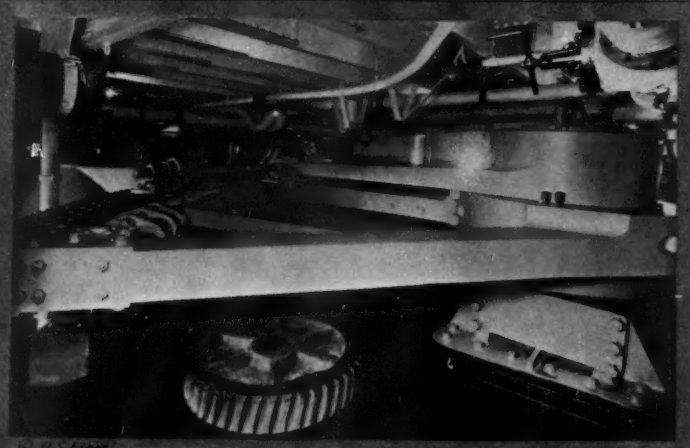


FIG. 12 QUADRANT OF STEERING GEAR ON
S.S. LEVIATHAN

Editorials

OPEN-HOUSE NIGHT

The student enrollment in most endowed colleges has been declining from the high point reached immediately after the World War, but the enrollment at Technology has been dropping much more rapidly than at other institutions. Evidence of this tendency is the fact that this year's Senior Class is larger than the present Freshman Class. A partial explanation of this condition is the transition of Technology from a wholly undergraduate institution to a graduate school. However, this explanation cannot account entirely for the abnormal decrease in registration, for the fact is that student enrollment has decreased more than ten per cent in the past four years. The situation is acute, because a certain proportion of the tremendous fixed charges of the Institute must be met by tuition fees. Remunerative research is a source of income, but it is never an assured one. Open-House Night is an effective means of interesting prospective students in undertaking a course of study at the Institute. Further, some paid research may be obtained through the interest aroused in an important class of visitor.

The popular conception of Technology, so often distorted to depict merely a glorified trade school, so hard that only a wizard can survive the four-year ordeal, may be corrected by Open-House Night. The number of prospective students now frightened away by the gruesome aspect of this distorted picture will be changed to a number of actual new students as soon as the illusion is destroyed.

An attempt this year was made to reach certain types of people with invitations to be visitors on this particular occasion. Invitations and posters were sent to some three hundred New England high schools and preparatory schools. The Youths' Companion "Y. C. Laboratory" of invention and science extended some two thousand five hundred invitations to its members. Professional men were reached through the professional societies in New England. Students invited their friends who were interested. As a result upwards of ten thousand persons were present to inspect the Institute.

A fair indication of the success of the effort to interest the person who can be of material assistance to the Institute is found in the gifts received this year of several new machines and pieces of apparatus. The total benefits to the Institute of Open-House Night are by no means immediate, and there is reason to believe that more people have become interested. Evidence of this new interest will be forthcoming in the future. With all these benefits accruing through Open-House Night, why should it not warrant the wholehearted co-operation of all the undergraduates and alumni of Technology?

DAVID HAMILTON McCULLOCH

It is with deep regret that we record the unfortunate death of Dave McCulloch, the past editor of T.E.N. A man very active in many phases of undergraduate activity, we knew him best through his work with the NEWS, where his greatest interest lay. We knew him as a man, as an editor, as a leader, but above all as a friend.

When the young die, the pain of the world is trebled. We have lost our intimate friend of the moment. We have lost the promise of a bright tomorrow. We have lost the garnering of happy memories.

When the old die, it is the well-earned arrival of peace. When the middle aged die, it is too often the abrupt end of a doubtful struggle. When the young die, it is a lessening of the song of the world — or of so many of its notes as speak of the joy of living.

And to those of his friends who are young, his tragedy is a shadow on each heart which serves to emphasize the thing he so cruelly lost — the bright inspiration of youth — youth which is all the warmth in the heart of all the world. Dave has left a gap that we will find it hard to fill, but the command is to close ranks — and carry on.

ABOUT THE JUNIOR PROM

When a social activity attains the dignity of an official designation, either that of a University, College, Class, or Course Function, it becomes then immediately of greater moment and a part of the business of all persons interested in the University, College, Class, or Course. It is well to understand that certain tendencies in college social activities are meeting at present with the disapproval of a large and somewhat influential group of the middle class citizen upon whose support the final success or failure of all nationally interesting social functions depend.

Democratic philosophies are dependent on the basic premise of some form of equality. Democratic philosophies always have been and always will be open to argument. Whether practical equality in anything is attainable or desirable is an academic question. There always was, is, and will be an aristocratic class. There always was, is, and will be a constantly changing conception of what this aristocratic class should be. The existence of an aristocracy, no matter what its conceptional basis may be, is right, and therefore desirable. It is a natural product. Like all perfectly healthy and desirable traits, a growth beyond certain well understood limits becomes an abnormality and an unhealth.

An aristocracy is good. An aristocracy founded upon total disregard of democratic principle is bad. It is like any other natural appetite which starts with perfect health and ends with perfect disease. A Junior Prom at the Copley-Plaza starting with an initial charge of $12 a ticket for a couple is a highly ludicrous proposition. This means a total charge per boy from $30 to $50. For any one group of students to give such a dance is entirely proper and possibly desirable. The function enters its absurd phase when it becomes labeled as a general class function. As a "junior promenade," it should be a joyous occasion for all members of this class who are to graduate a year from date or about that. An occasion when they are all to come together for an all-round good time. Whatever the theory on the subject may be, a charge for one social function of $30 to $50 is a flatly prohibitive charge. It creates feelings of bitterness in boys from poor homes, and it elevates ideas of social distinction based upon temporary monetary conditions to positions to which they are not entitled. It is a charge which makes distinct class rank between the affluent and the needy. It enters as a separation between classmates.

The proper place for a Junior Promenade is the largest hall belonging to the University, in this instance, Walker Memorial. The proper price for a Junior Prom ticket is $3 per couple.

(*Continued on page 154*)

The Engineering Field

Excerpts from the leading professional and trade journals

Electrification of lumber mills and logging camps is practically complete in the great lumber regions of the United States. This was done primarily because it eliminates the fire risk which accompanies steam boilers.

The various companies also found it to their advantage to have their own generating plants rather than buy the necessary power, since about one third of every log is wasted in sawing and planing. This waste is a source of sufficient fuel for generating the steam needed at the power plant. The power plant is usually located near the mill, which is within ten to thirty miles of the forest from which the lumber is being cut. Step-up transformers are used to raise the generator voltage for a transmission line to the center of operations. Here step-down transformers are needed to reduce the voltage for the hoists and other machinery.

These step-down transformers must be specially designed for rough handling, because they must be moved each day on massive wooden drags. The transformer used is constructed so that it has a low center of gravity, and the usual sheet steel radiator is replaced by "tubular" radiation, which is better able to resist blows.

These power plants range in size from 500 to 40,000 H.P., and all use steam turbines to run low voltage A.C. generators which are suitable for supplying current to motors in the near-by mills. Most plants have a surplus of power which they sell to power companies, since the wood waste produces about three times the needed power. —*General Electric*.

A Nitrogen Surface Hardening process in which the object to be case hardened is heated in an atmosphere of ammonia gas has been patented by Messrs. Krupp and is being used commercially in Germany.

The greatest drawback of case hardening by the usual methods is that it causes a distortion of the object. In many cases, due to the design, it is impracticable or even impossible to correct this warping by subsequent grinding. In addition to the distortion, there is also the scaling and oxidation due to multiple reheating at high temperatures. All of these disadvantages are eliminated, for all practical purposes, by the new process.

Previous attempts at case hardening in ammonia gas had all been carried out at temperatures between 600 and 850 degrees, and were unsuccessful due to the brittleness of the case, which was caused by the formation of certain brittle iron nitrides $Fe_2 N_4$ and $Fe_4 Ni$. Messrs. Krupp found that by carrying on this treatment at a temperature not exceeding 580 degrees until a sufficient depth of case has been obtained, and then allowing the object to cool with the furnace, that the formation of these brittle compounds is avoided. The time for cooling is lengthy, varying from 40 to 60 hours. At this reduced temperature as much as 2.5 per cent of nitrogen dissolves in the steel without any indication of brittleness. Part of this nitrogen combines with the iron to form nitrides which serve the same purpose as the carbides formed in the other methods.

The results obtained are remarkably uniform. The depth of case varies from .5 to .8 mm. and the Schleroscope figures vary between 104 and 108. The Brinell hardness of the samples was 223, corresponding to a tensile strength of 48 tons per square inch.

It was also found that when using steel alloys of aluminium, chromium, and manganese equal or better results could be obtained.—*The Metallurgist.*

New Type of Battleplane. Toward the end of the war the Germans brought to the front a new type of plane which was essentially a large bomber, heavily armed and armored, with the purpose of escorting bombing squadrons and fighting off pursuit plane attack. Except for the fact that they accounted for Major Roul Lufbury's death, the new planes were a failure largely because they were too vulnerable to machine-gun fire from lighter and faster planes. Although well armored around the motors and crew, they were easily shot down as soon as a structural member was pierced.

Recently, however, the French have been working on such a battleplane incorporating modern ideas, and a very interesting plane of the type has been developed by the Latecoere Company. The plane is a large biplane of 90 ft. spread, powered with four British Jupiter radial air-cooled motors of 400 H.P. The construction is entirely of metal, and the cockpits of the pilot, four gunners, and observer are protected by armor against ordinary machine-gun fire. The engine nacelles are also protected and are doubly invulnerable because they have no radiators which can be pierced. There is a formidable array of machine guns for fighting off the attack of pursuit planes, allowing no "blind" spots to fire in any direction.

Most interesting is the structure of the plane so arranged that a majority of the members can be completely shot away without seriously weakening the structure as a whole. To this end there are nine spars in the upper wing and seven in the lower, and the fuselage constructed, somewhat like a shell, has twice the required number of bulkheads and longerons, and can be riddled anywhere by bullets without failure. Under static test the wing structure has withstood a load of 30 tons, which indicates a load factor of 7.5, a very high one for so large a ship. Even with this great strength the structure has been so planned that it can be disassembled and all units stowed for transportation on a small French boxcar. The plane has a very good performance especially in climb, speed, and maneuverability, and is expected to be a formidable opponent to an attack squadron attempting to break through and reach a bombardment sortie.—*Aviation.*

A New Type of Refrigerator which has no moving parts has been perfected in England. It uses ammonia as the working fluid in an entirely sealed system. This system is especially suitable for small installation since it does not require constant attention.

A solution of ammonia is heated, preferably by electricity, in a cylindrical iron vessel. The water vapor present condenses and runs back into the vessel while the ammonia gas passes on and is condensed in a water jacketed tube. It then descends over baffle plates in another iron container where it is allowed to evaporate, thereby cooling the non-freezing mixture which surrounds the evaporator. The gas then runs into another tank where it is dissolved in a weak solution of ammonia and syphoned back into the generator or heating chamber. The whole apparatus is filled with hydrogen in order to keep the pressure uniform.—*The Chemical Age.*

A Wind Tunnel of variable density has been completed by the National Advisory Committee for Aeronautics. It is surrounded by a steel shell 35 feet long and 15 feet in diameter. A compressor is used to fill this shell and the entire wind tunnel with air compressed to a density up to 25 times that of air under atmospheric pressure. This increased density is known to allow for a corresponding decrease in the scale of the model making this type of tunnel free from scale effect.—*Aviation.*

A New Type of Spillway. In this new type of construction, the usual outside spillway is replaced by a conduit or Tefft Tube. This tube acts as a by-pass around the turbine for the excess water. This new design made feasible the Alcona and the Hodenpyl developments. The latter project involved the construction of the world's highest head dam on a soil foundation. If a tainter-gate spillway had been used, the cost would have been prohibitive.

There are a great number of advantages in using the new type spillway, the most outstanding being the great saving in cost, which, under certain foundation conditions, may amount to 43 per cent of the total construction cost; the others being that a head-increaser effect is obtained, winter spillway troubles are eliminated, the spillways can be operated from the power house, and that at any time it is possible to empty the pond. The only disadvantage is that all the water must pass through the power house and therefore deposits greater quantities of débris on the trash racks. This has been greatly reduced by the construction of a submerged drift catcher in front of the power house.

The energy of the water from the spillway is dissipated in a shallow tumble bay. Under the right conditions, it was found that the spillways had no effect on the turbines except to increase their power.—*The Wisconsin Engineer.*

Duralumin Propellers Win Trophy. The Collier Trophy, annually awarded by the National Aeronautic Association for the most outstanding achievement of the year, was won last year by Dr. S. Albert Reed for his development of the Reed Duralumin Propeller. The propeller is being manufactured in this country by the Curtiss Airplane Company, and is also being manufactured under license in Great Britain and France.

The Reed Metal Propeller is made from a single casting of duralumin machined and filed to the proper shape and balance. Because of its greater strength, the blade sections can be made thinner than on wooden propellers, making it especially adaptable for high-speed work where the peripheral speed of the blades exceeds the speed of sound. All the world's speed records for the past three years, both in this country and abroad, have been made solely with these propellers. On the latest Curtiss Racers, a thrust of 89 per cent of the shaft horsepower has been recorded, which is better efficiency than any other propulsive device has yet shown.

The maximum intensity of stress at any point on the blade even at these high speeds is less than 25 per cent of the elastic limit of the material, and a still smaller per cent of the tensile strength. It is known that when under excessive vibration the fatigue failure of duralumin does not occur until the stress is much higher than this figure. In Army tests of the propeller the cross-section of the blades has been reduced to less than 30 per cent by riddling with machine-gun bullets before the blade failed.

These propellers have been in service in many instances over two years and have shown up very well in the field. They do not warp or become pitted by rain or small pebbles, and the surface remains smooth without attention. They absorb no moisture, and therefore remain in perfect balance under all conditions, which is especially advantageous in the tropics. They bend, but do not break, when a ship noses over, and even when very badly bent they can be returned to the factory and reshaped at a small expense. They have been in practically standard service in the Air Mail for the past two years, and have increased the flying performance of the planes materially. —*Aviation.*

The Conowingo Project. This new hydro-electric project is to be built on the Susquehanna River, to supply the increasing power demands of the Philadelphia market. The initial yearly output is to be about 1,360,000,000 kilowatt-hours. This new plant, located in the state of Maryland, will be second in size only to the one at Niagara, which is the largest single hydro-electric plant in the United States.

Physical conditions at Conowingo are ideal. The river bed at the dam site is solid granite, and there is an unlimited supply of this same rock and sand near by, which are excellent for concrete.

The water level behind the dam will be maintained at 108½ feet above sea level. The discharge capacity of the spillway with all gates open will be about 880,000 cubic feet per second.

The power house will be 175 feet wide, eventually 900 feet long, and 230 feet from draft tubes to the switching station.

In the power house will be installed eleven of the largest water wheels in physical size ever built, being each of 50,000 horsepower. Ultimately 550,000 horsepower will be developed. The current generated at 13,800 volts will be stepped up to 220,000 volts for transmission, over two lines, to Philadelphia, about seventy miles away.—*Stone & Webster Journal.*

Progress on Test Dam. Plans for the methods of testing the Stevenson Creek Dam, which was described in the January TECH ENGINEERING NEWS, have been completed. This dam has been built for the sole purpose of gaining information.

The engineers intend to make three main measurements: deflection, strain, and temperature. In each case, two or more methods are to be used. Deflections will be measured from five steel towers located on the downstream side and extending the full height of the dam. Each tower is protected from the wind and unequal temperature stresses by a wooden shelter. At every five feet, on the vertical face of the dam, are set invar distance pieces which extend between the tower and dam. The deflection is measured electrically at a central station. A second measurement of deflection will be made with a special clinometer and the third with the theodolites.

Deformation is to be measured both on the upstream and downstream side of the dam by means of 150 carbon disk telemeters prepared by the Bureau of Standards. Temperature measurements will be made both directly and by means of a coil of wire which will provide an electrical index of the temperature at each telemeter location.

Special care is being taken in order to have the concrete uniform in regard to the sizes of aggregate used, water-cement ratio, and time of mixing. Specimens which are being prepared will be tested at the end of 7 days, 28 days, and at the time of actual failure of the dam.—*Engineering News-Record.*

Double-duty Heater. The largest film company in San Francisco has installed gas-heated ovens for drying photographic film and prints. After the heated air has served this purpose it is used to furnish ample heat for the work-rooms and offices in a three-story plant.—*Industrial Gas.*

Photo-electric Cells have been put to a new use. These delicate pieces of electrical apparatus which made possible the sending of pictures by wireless are now being used to detect forest fires. A searchlight is carried on a cable strung between two mountain-tops, and so arranged that its beam is always focused on a photo-electric cell located on the platform of a forest fire lookout station. When the beam of light from the searchlight is dimmed by smoke, the current in the photo-electric cell is reduced and an alarm is sent in. This apparatus does away with continual observation by forest rangers.

Here and There

Interesting notes from the Editor's desk

COMMON ABSURDITIES IN PHYSICS PARLANCE

Pascal, whose "principle" is badly messed up in nearly every physics text known to the writer, laid down a good rule for us to follow in our endeavor to recognize and understand the principles of physics. "Nothing," says Pascal, "is needed but good eyesight, but it must be good, because principles are so minute."

Let us consider the mechanical principle of work with the help of Pascal's philosophy.

"A force does work when it moves a body." This statement certainly involves more than good eyesight; what does it mean to say that a force moves a body? The reader may know what it means, but the writer certainly does not know except in a hopelessly vague way. Anyway, imagine a mouse and an elephant to be hitched up to a wagon as a team. The mouse certainly does work because *the wagon moves in the direction in which the mouse pulls;* but is it not absurd to say that the mouse does work because *it moves the wagon?* This point of view shows scant respect to the elephant! No, the mechanical principle of work is correctly stated thus: a force does work when the body on which the force acts moves in the direction of the force, and anyone who has eyes can understand what this means. It makes no difference whatever as to what moves the body!

A string 10 feet long is tied to a post, and a pull of 5 pounds is exerted on the post by pulling on the string. This force certainly "acts through a distance of 10 feet" because the string is 10 feet long, and "work is done when a force acts through a distance" so that 50 foot-pounds of work is done on the post! This argument has been found by test to be acceptable to about 60 per cent of the men beginning a college course in mechanics! No, *work is done when a body on which a force acts moves in the direction of the force*, and no dictionary ever defined the word *through* in a way to justify the use of the word to abbreviate this 18-word statement of the mechanical principle of work as it is usually abbreviated in the study of physics in school and college. Language has been developed as a medium for dickering, quarreling, and lovemaking, and language as used in precise physical specifications is always more or less awkward and more or less strained; but it is a serious mistake to attempt to obviate these things by using meaningless expressions and phrases.

A very great deal of the difficulty which young men have in the correct application of the principles of physics comes from meaningless and ambiguous statements which young men accept as statements of principles. Years ago the writer gave a test problem to a group of engineering Freshmen who were nearly finished with their Freshman mechanics. A cart moves northwards at a speed of 2¾ feet per second. A mule exerts a northward pull of 50 pounds on the cart and a man exerts a downward push of 250 pounds on the cart. Required, the rate at which the mule does work and the rate at which the man does work. Forty-five per cent of a large class found that the mule was doing ¼ horsepower and the man 1¼ horsepower! If the part of his body used by the man in pushing on the cart had been named in the statement of the problem, no one would have entertained such an absurd result; and if the correct and clearly intelligible statement of the principle of work had been kept in mind, every man in the class could easily have found the correct answers.

It is highly important to frame up statements of definitions and principles in physics as referring explicitly to actual physical things. Thus it is largely meaningless to say that "power is rate of doing work," no, the power of an agent is the rate at which the agent does work. It is physically meaningless to say that "density is mass divided by volume," the correct statement is that the density of a body is equal to the mass of the body divided by its volume. To say that a kilowatt-hour is the work done in one hour by a kilowatt is absurd; who ever saw a kilowatt, and how can a kilowatt do work? No, a kilowatt-hour is the amount of work done in one hour by an agent which does work at the rate of one kilowatt—and by agent we do not mean an insurance agent! Ask a student about the accelerating effect of a force and he is apt to make the following sounds in answer—*eff equals emm aye*, as if the naming of the letters in an equation could possibly pass as a physical statement!

PROF. WILLIAM S. FRANKLIN.

TRANSFORMED NEWS NOTES

Stories usually gain by retelling, and so, it seems, do our carefully written "News Notes." Here is one that has just come back to us via *The Transit*, Iowa:

"A new thermostat working like the bottom of an oil can has been patented. Its advantage is that the action is very sudden and complete at critical temperatures. It is the first basic patent on thermostats since the discovery of the bimetallic principle."

Short and snappy, easy to remember — perhaps we should write them this way. See if you can recognize its predecessor in our October, 1925, issue.

TWO MORE WRINKLES SMOOTHED OUT

The portable house idea is now used by a street car company. To facilitate the moving of passengers during rush hours, portable booths are placed advantageously for passengers to purchase their car tokens quickly.

The rush-hour traffic congestion has so far meant a high mortality rate for the small traffic signs left unprotected at street intersections. Now there is a fool-proof sign in use. It has a weighted ball and socket base which operates to raise it to its correct position as often as it may be knocked down by careless or indifferent vehicles.—*Electric Traction.*

IT COSTS SOMETHING TO CREATE A GOING CONCERN

Is it fair to expect a man who had spent four years of hard work and a considerable sum of money in studying technical engineering to go to work for fifty cents an hour? The question is raised by a senior who is beginning to think of the future immediately ahead of him. It has suggested an analogy between the newly graduated engineer and the man who has just gone into business. The latter knows that, even though he has invested just as much money as an established competitor may have done, and even though he works as hard or harder, his earnings for a time will not be so great — in fact, he may have to operate at a loss for a time. Eventually, he expects to become established and to make up his losses. The money loss incurred in the early months or years of a business constitutes a recognized part of the cost of development. When a going concern changes hands, the sale price is always placed well above the value of the physical plant in order to cover the cost of building up the business.

The graduate engineer faces the task of making a going concern of himself, and the mere fact that he represents a considerable investment in time and money will not relieve him of the necessity of going through the development period. Not many of the graduates are forced to operate at a loss during the time that they are establishing themselves. In that respect they have an advantage over many business men and over many other professional men. —*Wisconsin Engineer.*

The big or little company —*which?*

"YOU'LL surely be buried in the big company," say some. "Everything is red tape, and you'll end up in a groove in some little department."

"Your little company never gets you anywhere," others assert. "The bigger the company the bigger your opportunity."

Whether a plant covers a hundred acres or is only a dingy shop up three flights is not so important as whether the company is concerned with improving its product through the development of its men and their ideas.

There are ably managed and growing companies in growing, forward-looking industries which offer you a chance to grow with them.

Published for the Communication Industry by

Western Electric Company

Makers of the Nation's Telephones

Number 58 of a series

Recent Books

This department conducted in co-operation with the Technology Library

The Biology of Population Growth. By Raymond Pearl, Director of the Institute of Biological Research, Johns Hopkins University. New York: Alfred A. Knopf. 260 pp.

Raymond Pearl has given us another thoughtful and stimulating book in "The Biology of Population Growth." While the book contains various hypotheses and conclusions with which the informed reader may disagree, all must admit that it is thoughtful, stimulating, and worth while.

Pearl sets out to understand the growth of human populations by studying the growth of yeast cells and banana flies, and finds that the laws applicable to the increase in the members of these living things are essentially applicable to man. Searching about for a human group which has not been affected by modern industry and civilization, the indigenous population of Algiers is selected, and the birth rates, death rates, and increase in numbers are studied over a period of seventy-five years. Pearl demonstrates, though not to one's entire satisfaction, that the death rate among these people has been coming down according to the same rate observed in civilized countries, in spite of the absence of public health measures. Similarly, although birth control measures are not practised and the relationship between the sexes is exceedingly gross and brutal, the birth rate among these people has also been diminishing, and at a rate similar to that in civilized countries.

Studying next those factors that make for a reduction in fertility of matings, Pearl concludes that density of population, whether it be among banana flies and hens, which can be artificially controlled, or among humans, does actually diminish the number of offspring. Similarly, Pearl also believes that poverty, with its attendant shortcomings, such as poor housing, lack of proper and adequate food, reduction in opportunities for amusement and recreation, leads to greater fertility, while the reverse condition leads to a reduction in fertility. Interesting data are presented on the sex habits of men of different economic and social strata, and Pearl concludes with a strong plea for birth control as a means of limiting the number of offspring among the poor.

PROF. M. P. HORWOOD.

Industrial Fermentations. By Paul W. Allen, University of Tennessee. The Chemical Catalogue Co., Inc., 1926. 424 pp.

For many years fermentations have been carried on but with only a limited knowledge of what was bringing about the changes or how the resulting products were being formed. With the development of the biological sciences it has become possible to understand and more closely control older methods, and many entirely new processes have been developed and have reached the commercial stage. Dr. Allen's work is a compilation of the facts that have been discovered in regard to the many industries that control the actions of yeasts, moulds, and bacteria. These processes may be productive as are the industrial alcohol and vinegar industries, they may destroy the organisms as in the preservation of wood or the canning industry, or they may improve the product as the ripening of cheese or the curing of cheese.

Dr. Allen has divided the field into industries, and for each has discussed the raw materials, the chemical reactions and equations, the organisms involved, and the uses of the finished product. The parts that are not biological in nature are given in only the briefest possible outline.

There are thirty-one chapters, each dealing with a separate process or group of closely related processes. Some of these consist of only three or four pages, but the older and better-known procedures are adequately treated. The amount of space that has been assigned to the several different subjects seems to have only a remote relation to the amount of work done on the subject or the relative importance of the subject. The production of butyl alcohol by the fermentation of cornmeal seems to be the most obvious omission.

The book is well adapted for a class of college students that are studying the industrial uses of micro-organisms. It is not complete enough to be used as a reference book for the control of the processes mentioned. It has a tremendous value in bringing before the public in a single volume a list and description of the industries that use the old but newly developed method of getting results, and at the same time it suggests the very large field that is just opening to students of applied biology.

There are many diagrams, illustrations, and tables throughout the text. There is a bibliography at the end of each chapter that would be an invaluable aid in a further study of any one of the subjects treated.

PHILIP K. BATES.

Air Service Engine Handbook. By Iskander Hourwich. Published by Engineering Division, Air Service, Dayton, Ohio, 1925. 738 pp. Illustrated.

In many ways this is the most complete publication yet attempted in connection with aeronautic engines. As stated in his preface, the author has attempted to compile the most trustworthy information available on design, performance, and research. He has endeavored to confine himself to facts rather than opinions, and in this respect has achieved a commendable degree of success.

Chapter 1, devoted to conversion tables, physical constants, etc., contains much material which is available in the standard handbooks, although an attempt has been made to select such data as would be of especial convenience to the airplane engine designer. The atmospheric data included at the end of the chapter are of especial value, as they are not available in this convenient form in other publications.

Chapter 2, on engine weights and dimensions, is perhaps the most valuable part of the book, even though most of it applies to obsolete or obsolescent types. Here is one of the few sources to which the engine designer can turn for dimensional data on a large number of aircraft engines. This should be very valuable in checking up new designs. The writer knows of no other place where such a large amount of material of this nature is available.

Chapter 3, "Materials," is very complete and furnishes a well-condensed reference on this subject. Since materials do not become obsolete as rapidly as engine designs, this chapter suffers less from the time which has elapsed between the compilation and printing of the book.

Chapter 4, on performance data and testing, is similar to Chapter 2, in that it furnishes a large amount of collated data on aircraft engines in convenient form and well presented. Examination of this material discloses the fact that the performance characteristics of engines of quite similar design show extreme variation for no apparent cause. For example, it would be expected that there would be an approximate relation between mean effective pressure and the gas velocity through inlet valves, but the diagrams on page 400 show no definite relation of this kind. After perusing this chapter, one is forced to the conclusion that there are so many variables in engine performance that it is impossible to isolate factors which have a consistent effect over a wide range of engine design.

The chapter on fuels and petroleum technology impresses the writer as a rather heterogeneous compilation from many authors. Although it contains much of value, it would be difficult for the uninitiated to make an intelligent selection from the large number of data included. It is a pity that the space devoted to the technique of conducting fuel tests, which is of very little interest to the designing engineer, could not have been used to explain and interpret the meaning of these tests. For example, while detailed instructions are given for conducting the "Doctor" test, no explanation is given for the meaning or purpose of this test.

Chapter 5, on lubrication, suffers from obsolescence, since rapid strides in theory and experiment have been made since the volume was compiled. The description of typical lubricating systems is of some value.

The chapters on carburetion and ignition are especially complete, the former giving a great deal of experimental data applicable to particular designs, while the latter is largely devoted to theory and experiment in connection with the magneto.

Cooling and installations are discussed very briefly in the last chapter, a large part of which is taken from the Air Service "Handbook for Airplane Designers." The book is well indexed, a necessary feature of a volume of this type.

The chief difficulty in publishing a handbook of this type results from the fact that the art is in such a rapid state of advance. This is especially noticeable in the case of the volume in question, since, through no fault of the author, it was printed fully three years after compilation. Another difficulty is insuring the accuracy of the data used. As it is impossible to secure accuracy in every individual case, the data given are chiefly of value in showing trends and general effects. This, however, is the principal purpose of such information.

Considering the magnitude of the task, the author is to be congratulated on having compiled the most valuable American publication on aeronautic engines.

PROF. C. F. TAYLOR.

The Oil Industry — Production, Transportation, Resources, Refining, and Marketing. By Ernest Raymond Lilley, Sc.D., Assistant Professor of Geology at New York University. New York: D. Van Nostrand Co., 1925. 8-vo. 548 pp.

The book begins with the nature and origin of petroleum and the organization of the industry. Following this are interesting chapters upon exploration, and American and foreign leases, showing a wide knowledge of the subject. Two long chapters upon drilling describe the different systems employed—cable, rotary, and diamond; fishing, controlling, packing, and leasing operations are then detailed.

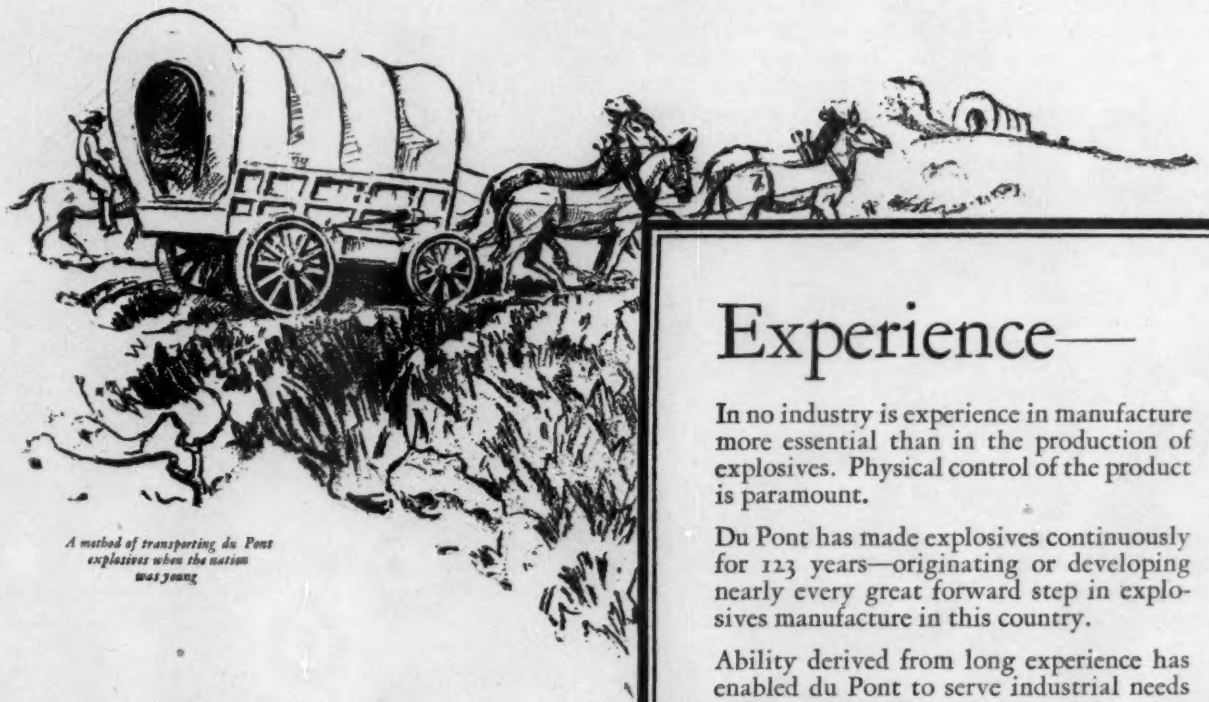
Four chapters discuss the oil fields in the Americas, Mexico, Cuba, Canada, and the old world; here the geology, kind of oil, and — as far as possible — the future of the industry are considered. Important chapters upon transportation and storage, and the marketing of crude oil, follow. Here, and in the chapter upon the marketing of refined oils, an insight is given into the business side of the industry, which is unusual and difficult to obtain.

The chapters upon refining, cracking, and compounding are brief, up to date, and to the point. Anyone, though he be ignorant of chemistry, should have no difficulty in comprehending them.

The work closes with three entertaining chapters upon world corporation control, competitive and substitute industries, and the future of petroleum.

PROF. A. H. GILL.

MAKERS OF POWDERS SINCE 1802



A method of transporting du Pont explosives when the nation was young

Experience—

In no industry is experience in manufacture more essential than in the production of explosives. Physical control of the product is paramount.

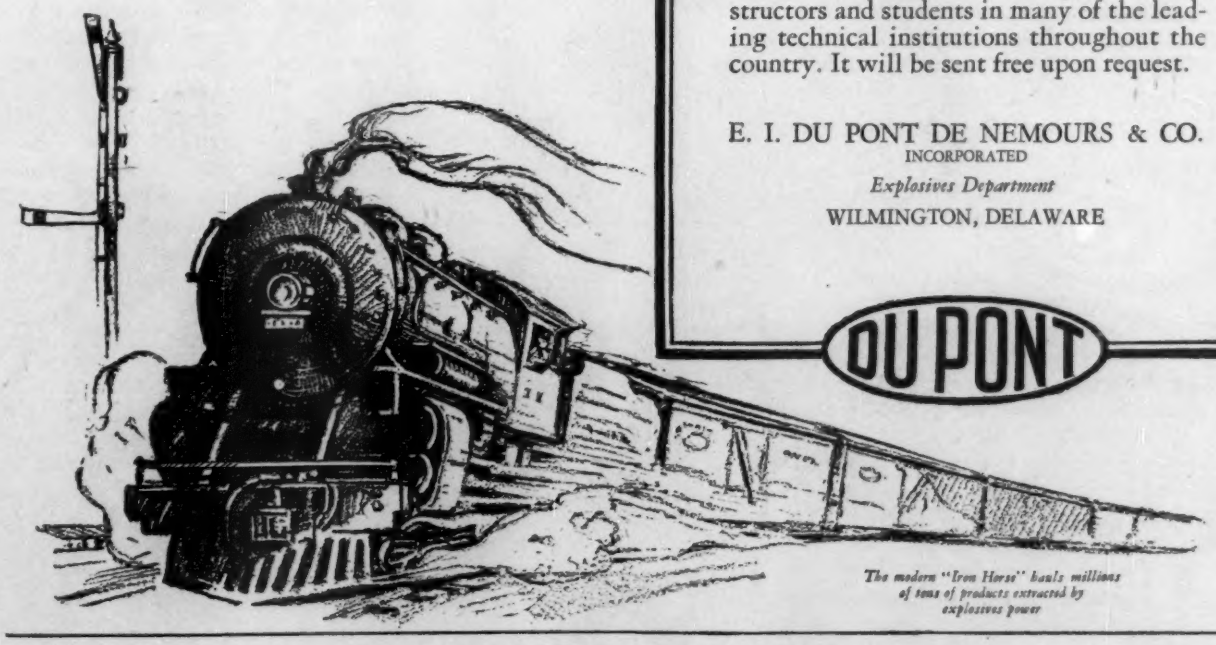
Du Pont has made explosives continuously for 123 years—originating or developing nearly every great forward step in explosives manufacture in this country.

Ability derived from long experience has enabled du Pont to serve industrial needs and even to anticipate those needs by originating new methods, new processes and new products.

The most efficient methods of employing modern explosives may be found in the "Blasters' Handbook,"—a practical and authoritative work now being used by instructors and students in many of the leading technical institutions throughout the country. It will be sent free upon request.

E. I. DU PONT DE NEMOURS & CO.
INCORPORATED
Explosives Department
WILMINGTON, DELAWARE

DU PONT



The modern "Iron Horse" hauls millions of tons of products extracted by explosives power

123 YEARS OF LEADERSHIP IN THE SERVICE OF INDUSTRY

The 1926 Graduate — Planning a Career

(*Continued from page 109*)

self with sufficient information of an industrial nature in order that he may have a perfect poise in the affairs with which he is engaged.

That the demand for engineering and chemical research in business will continue to increase cannot be questioned. As the country continues to become more and more industrial, and as plants and factory space are multiplied, competition alone suggests that departments of special investigation must be greatly expanded. In the last decade, and especially since the outbreak of the War, there has been an astonishing increase in this respect. There are already hundreds of commercial organizations which have research departments contributing to the success of the business.

Besides the vast amount of work being done by federal, municipal, and educational institutions, there is the work of laboratories instituted by trade associations, foundations, and kindred organizations. But above and beyond all this are the research efforts of corporations, varying from the Western Electric Company laboratories with nearly 2000 employees, and the Du-Pont staff of over 500, the Akron tire companies, General Electric, Westinghouse Electric, and the great General Motors Research Corporation with its six acres of floor space—down to the concerns employing only two or three engineers or chemists. Such is the tendency of modern business, and the future of trained technical men with the vision above referred to is almost monumental in its possibilities.

Into this vast field the graduate is about to plunge. Too often the plunge has been haphazard, with very unfavorable results. Do not forget that there are, in any period, lines of industry which are dying or becoming obsolete, and *vice versa*, lines which are in the morning of their eventful day. It is futile to select a life-work in the "stage-coach class." The tractions companies, to retain the vehicular figure of speech, have for several years been declining in their importance and prosperity as a result of the advent of motor car and motor truck. The New England textile trade for the last five years has prospered far less than many other forms of industry, but the plants which have introduced rayon processes have ridden the top of the wave. These are simply illustrations of what the graduate must constantly know.

The electrical field, as it has been for thirty years, is still an industry of paramount importance. Those who can reach a leadership in this department of activity are practically assured of most attractive opportunities. The year 1925 was second to none in its remarkable developments.

The merger or so-called super-power situation has been unprecedented. Nearly 600 companies were last year involved in projects for centralization of management, power pooling, interconnection, and co-ordination of resources. Just ahead of us lies the interesting area of further development of current at the coal mines and its transmission to the big industrial centers. Over half the population of the country is living in electrically lighted houses. Sales of appliances of all kinds are being pushed with tremendous success, and the electrical appliance business is a very fertile field.

One might suppose from this that the gas lighting and heating business is in the discard. Far from it, the progress of gas heating was never more auspicious. With all the trouble and annoyance existing over the coal situation, it is more than likely that heating of dwellings by gas is a coming necessity. Oil heating is now having its swing, but it is probable that gas will sooner or later attain the ascendency in this respect.

When we turn to the automotive industry, and when we think that there is now one automobile for about every six persons in the country, there is no need to say more. The automobile has practically torn to pieces and rewoven the whole social fabric. It has already nearly wrecked the electric street railway industry in many localities. It has built up at least three great new industries — manufacture and sale of passenger cars, commercial cars, and buses.

It is throwing a network of highways across the country, creating vast changes in real-estate values. It has developed an entire catalog of great subsidiary industries such as tires, equipment, parts, etc. It is developing the giant gasoline industry. It has profoundly affected the family budget, claiming so large a proportion of family expenditure that less remains for some of the older lines.

There are still opportunities in the automobile industry in its three branches — passenger cars, commercial cars, and buses. The bus industry is only in its infancy. There are also great opportunities in indirectly taking advantage of some economic reactions of the motor trade. For example, the automobile will continue to be a tremendous factor in the development of suburban real estate. There is also little question but that we are on the eve of considerable changes in the motor trade itself. Among other things, there is the probability of a much more efficient fuel and a motor designed to utilize it.

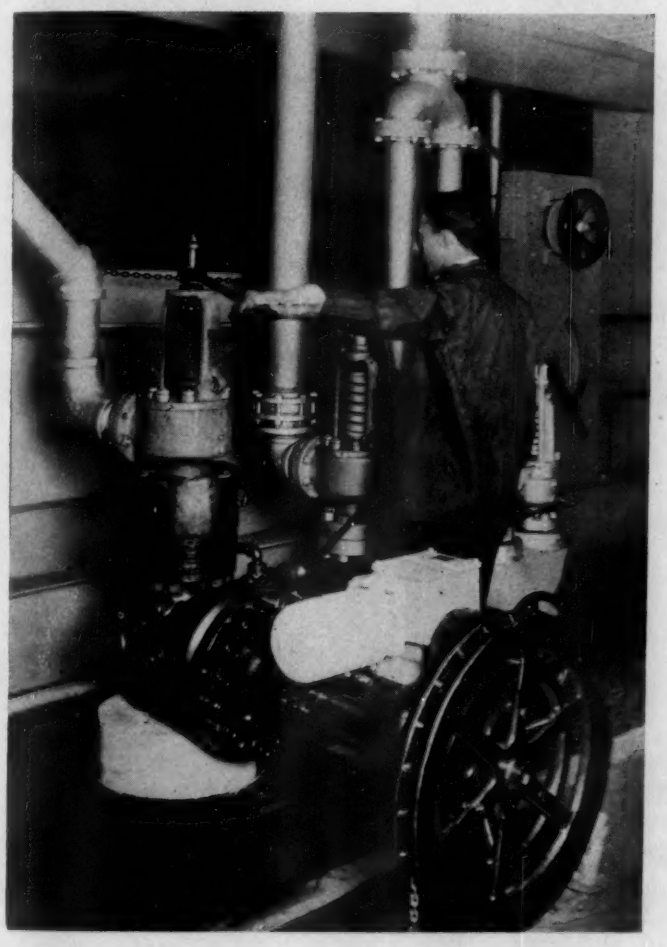
The colossal development of the automobile has created new problems of highways and bridges. There has arisen a host of traffic problems of sufficient importance and complexity to utilize the abilities of the most ambitious engineer. While there has been decline in tractions, this has been more offset by the astonishing advance of motor trucking. The complexion of whole cities will thus be changed, and a great field for the engineer is opened up. F. W. Fenn, of the National Automobile Chamber of Commerce, states that the following problems are imminent:

1. The development of parallel lines to divide heavy traffic through thickly populated districts.
2. The development of direct, short-mileage routes, although on these routes there may now be a less amount of improved roads than on routes now followed.
3. The building of inner or outer belt lines around congested centers.
4. The reconstruction of weak sections for heavy truck traffic.
5. The widening of main routes near the largest cities or between cities where distance is short enough to carry uniform traffic.

This brings us at once to the question of architectural planning for such great civic changes. One of the great fields of the future is that of the architectural engineer. There are several reasons for this. There is the remarkable development of the city and its suburbs. Another most potent influence is the improvement in public taste. Appreciation of beauty will be far more dominant in the United States than formerly. The far-sighted graduate should visualize the past history and future opportunities of the United States. He should trace the awakening of this country from an agricultural and somewhat provincial nation to a new nation, first intensely industrial and now permanently turning toward an awakened beauty and convenience. No longer will cities and structures be allowed to develop haphazard. There has sprung up the new activity of city-planning. The subject of zoning has become almost a vocation in itself. Everywhere the graduate may expect to find a rising standard of living, a tendency toward greater beauty and

(*Continued on page 132*)

STANDARDIZED SAFETY VALVES



THIS VIEW SHOWS

testing unit of the High Pressure Steam Testing Laboratory of the Consolidated Safety Valve Company, Bridgeport. An actual test is being made of one of the drum valves for the 1200-lb. boiler installed at the Weymouth Station of the Edison Electric Illuminating Co. of Boston.

For High Pressures

POWER PLANT engineers are turning to higher steam pressures as a means of economy in producing cheaper power. From 300 lbs., the highest pressure generally used a few years ago, has come the remarkable advance to 400, then to 600, 700, and finally to 1200 lbs. per square inch.

Consolidated Safety Valves tested upon the new 1200-lb. Steam Testing Laboratory of The Consolidated Safety Valve Co. have been installed, or are being furnished, for practically all of the higher pressure stations such as the following:

Form DSA Valves for stations carrying approximately 400-lb. pressure as follows:

The Trenton Channel Station of The Detroit Edison Co.
The Richmond Station of the Philadelphia Electric Co.
The Avon Station of the Cleveland Electric Illuminating Co.
The 14th Street Station of the New York Edison Co.
The Spencer, North Carolina, Station of the Southern Power Co.

Form DSB Valves for stations carrying approximately 600-lb. pressure as follows:

The Philo Station of the Ohio Power Co.
The Crawford Avenue Station of the Commonwealth Edison Co.
The Twin Branch Station of the Michigan & Indiana Electric Co.
The Miami Fort Station of the Columbia Power Co.

Form DSC Valves for the Stanton Power Station of the American Gas & Electric Co., carrying approximately 700 lbs.

Form DSC Valves for the Weymouth Station of the Boston Edison Company, carrying approximately 1200 lbs.

These installations are the best proof that Consolidated Safety Valves for high pressures have passed through the development stage and are being furnished to the trade as a standardized product.

MAXWELL M&M MANNING & MOORE INC. TRADE MARK

"Shaw" Electric Cranes
"Putnam" Machine Tools
"Ashcroft" Gauges
"Hancock" Inspirators and Valves
"Consolidated" Safety Valves
"Metropolitan" Injectors

Manning, Maxwell & Moore, Inc.

100 East 42nd St., New York

Branches

Birmingham	Chicago	Philadelphia	Seattle
Boston	Cleveland	Pittsburgh	St. Louis
Buffalo	Detroit	San Francisco	Syracuse

[BRIDGEPORT WORKS—CONSOLIDATED SAFETY VALVE CO.

The 1926 Graduate — Planning a Career

(*Continued from page 130*)

luxury. This means everything to the wide-awake architect.

The radio and its associated lines is so widely advertised that it seems gratuitous, and yet it is only in its infancy. Like every new business, it will have periods of temporary reaction, but when we think of its world-wide possibilities in wireless transmission, its importance is second to none. Great improvements are coming on the broadcasting as well as the receiving end.

The radio is also bringing about important changes in a social and economic sense. Because of the radio, certain localities which were formerly almost entirely isolated are in effect brought hundreds of miles nearer the great metropolitan centers. From the standpoint of practical living-conditions, a farm may soon be worth far more than years ago, simply because radio, the auto, and electric transmission have made the location more livable. The same thing applies to suburban localities.

The time is near when it will be possible to transmit not merely sound but pictures. We shall then have by radio not only moving-picture films, but radio transmission of important news, documents, and public events. In fact, as I write, the morning news tells of a check by radio honored at the bank! If visual radio develops as rapidly as audible radio, here is another industry of immense possibilities and offering unlimited opportunities to competent men. Moreover, the field may soon develop for broadcasting not only sound and light waves, but other forms of energy, such as heat and power. This may be in the more distant future, but it is one more reason for believing that the whole subject of radio is one of far-reaching importance. Those interested should at once get in touch with the Radio Corporation of America.

And so one might continue to enumerate. What of the wonderful chemical research and its results of the next ten years? What of the coming application of the X-ray to business — its analyses of the crystalline structure in the various processes of manufacture? What of its intimate revelations relative to fuel combustion? What is it that makes glue stick? What keeps varnish from cracking? Why do certain processes in making rayon give better results than others? How can we increase electrical conductivity of metals? How can we make castings to compete with forgings? These are a few of the questions which the X-ray is solving, and suggests the field it offers to the engineer.

To aid the graduate who is trying to find his bearings in a vast field of industry, I have prepared the accompanying chart. It is based upon the official figures of the Census Bureau, and shows the annual value of products for selected industries in the various years. The Census Bureau tells me that 1925 results are not yet published, but every graduate who is contemplating industrial work should be on the lookout for these figures, and when they appear he may bring this chart up to date. The graphs are plotted on a logarithmic scale, and therefore the relative slopes of the lines correctly picture corresponding percentages of increase or decrease. I strongly recommend that every graduate prepare a chart similar to this, but covering the particular lines in which he may be personally interested.

The graduate seeking to orient himself should also consider which of the following broad departments of economic activity offers opportunities best fitted to his personal qualifications and preferences: (1) Production; (2) Distribution; (3) General.

Under "Production" are included the purely extractive industries — mining — and industries turning out fabricated products such as automobiles, or semi-fabricated products such as steel shapes. Under "Distribution" are included concerns such as jobbers and retailers which obtain from other hands the products distributed. Under "General" we include those activities such as transportation, communication, and various forms of service like accounting, which can hardly be classified under either Production or Distribution, although closely allied.

The technical graduate who is contemplating the choice of some field of production would do well to obtain the Census Bureau list of about 300 kinds of manufacturing industries. For each of these 300 branches of industry the Census Department gives statistics (as illustrated in the accompanying chart) from which you can judge the industry's relative magnitude, rapidity of growth, and other tendencies. Certainly an intelligent choice would hardly be made without some reference to this wealth of data. An examination should also be made of the trade journals in the major fields of industry. Invaluable information can be gleaned from this source as to the industry's importance and probable future, together with significant tendencies. Most of the larger industries have trade associations, which are another source from which information can be obtained.

It is becoming increasingly evident that there is a most remarkable opportunity for the application of scientific methods to distribution. This is particularly pertinent in view of the present tendency toward the growth of distributing mergers, instead of the smaller independent units of earlier days. For example, we had first the merging of independent stores into chains, and we are now witnessing the merging of separate chains into still larger chains and also the merging of smaller retail units of department stores into still greater organizations.

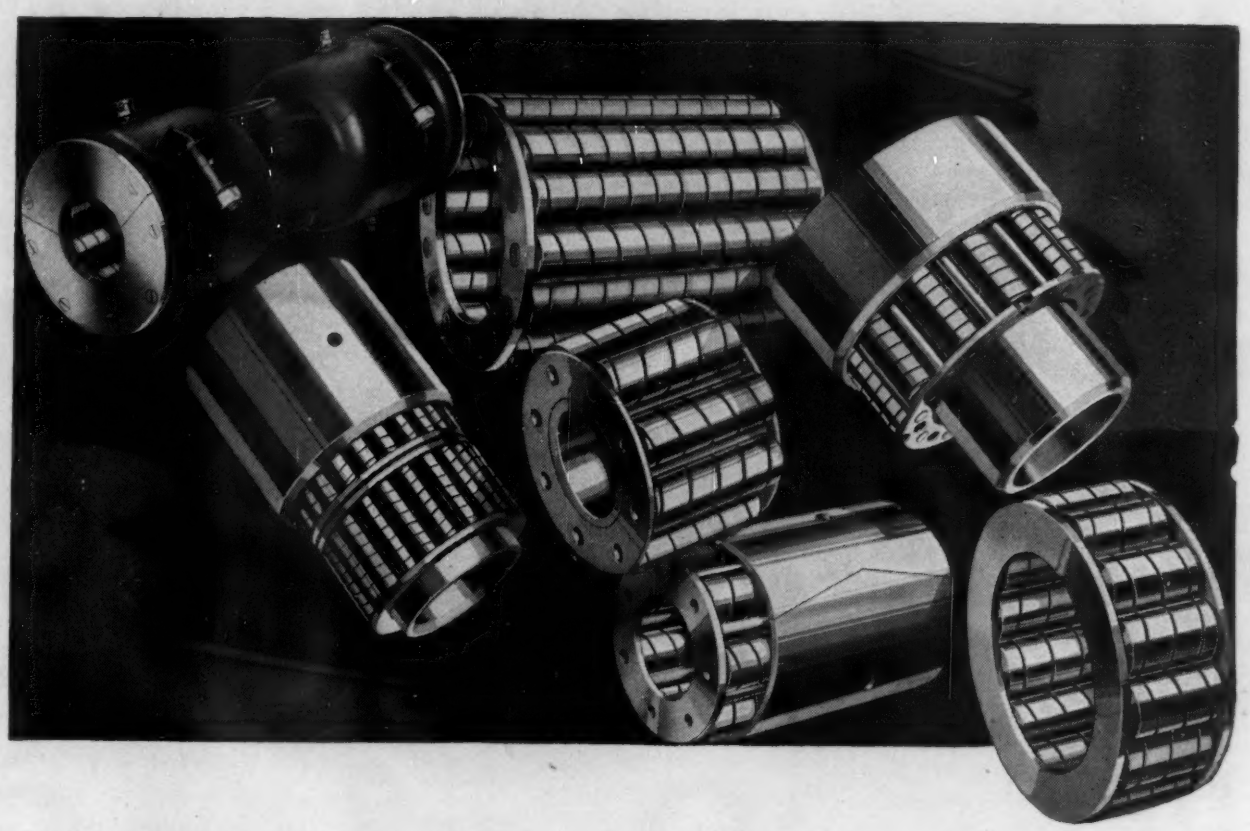
This means that there is an increasing opportunity for accounting and engineering methods. Therefore we say that there has never before in history been a time when conditions were more favorable for the employment of technically trained men in our great distribution problems. The engineer who undertakes to promote greater efficiency in distribution has no easy task, but the rewards will be substantial.

One vital aspect of a career is the matter of selecting a locality. Few individuals have the genius to reach their fullest possible success in the face of adverse local conditions. There are likewise few men whose prosperity is not enhanced by the proper choice of location for their activities. Other things being equal, the technical worker who identified himself with a rapidly growing region has a distinct advantage.

I have recently completed a population analysis covering all states in the country from the latest estimated population for July, 1926, and reaching back to 1790, or to the earliest recorded enumerations. I have before me the charted results of this survey. It is truly remarkable to see the wide variation in the present rate of growth in different parts of the country. California, for example, makes an impressive showing, and, of course, we find a spectacular jump in Florida. Michigan is going ahead very nicely. Still small in absolute size, Arizona is making good percentage gains. An interesting fact is that some of the largest states, such as New York, Pennsylvania, Illinois, Ohio, and Texas, in spite of the dominant position already obtained, still continue to show a relatively rapid rate of growth.

One of the most interesting regions is the South. A conspicuous example is the great textile industry. The

(*Continued on page 146*)]



There's a Hyatt Answer to Your Bearing Question

Hyatt Roller Bearings are used the world over. They are installed in numerous types of equipment—manufacturers representing over forty different industries include them as standard in their products.

A large majority of all American made gasoline tractors and power farm implements depend upon Hyatts for efficient bearing performance. Nearly all the better grade of passenger cars and trucks are equipped with them.

Their application in lift trucks, trailers, etc., has increased the load pulling capacity of workmen.

In steel mills where bearings are subjected to terrific thumping service, Hyatts guard against breakdowns and delays.

Textile machinery, line shafts, contractor's equipment, conveyors, etc., operate at maximum capacity for longer periods and at less expense when easy turning Hyatts are substituted for the rubbing friction of ordinary bearings.

In nearly every country on the globe, Hyatt equipment is selected when constant dependable service must be assured. For thirty years and more, the use of Hyatt Roller Bearings has been expanding. You, perhaps, will some day assist in extending their use. When that time comes, the resources of Hyatt are at your disposal. *Hyatt Roller Bearing Company, Newark, N. J.*

HYATT
ROLLER BEARINGS

A Letter from an Engineering Executive to His Son

(*Continued from page 107*)

if you are engaged in work or surroundings that are dirty, to dress as if you were attending an afternoon reception.

Punctuality an Important Factor

Whatever be your hours of duty, see that you are punctual — if anything, a little ahead of time. Above all things, do not be a clock watcher. Do not get the habit of leaving the plant before closing time unless you have been told to do so. Your work and your interest in it should take precedence at all times; these should be your first and greatest considerations. There is one point, however, that you should bear in mind in this connection. Regularity in eating is desirable for your health's sake. Non-observance of this point when long continued is likely to result unfortunately, and many a young man has thus laid the foundation of future ills. Occasions will arise when meals must be omitted or delayed, but regular irregularity in this respect is neither necessary nor desirable. The man who cannot so arrange his work that he can leave it at stated times is lacking in some phase of managerial ability.

You must place youself and your services at the disposal of your employers night and day, Sundays and holidays, if such be required. It is often said, and it is true, that a man gets paid only for the services that he gives. Be sure that you give more than is required of you if possible. Do not concern yourself at this time about the remuneration; that will surely come later.

The Value of Promptness in Keeping Appointments

Be prompt in keeping appointments; and this applies not only to those made with your superiors, but also to those made with those who work under you. If you are late in keeping an appointment, you are delaying the game — to use a sporting term — you are keeping someone from his work. You would quickly condemn this lateness in others and you must yourself set an example for those under you.

Much of the work will be new to you, in fact, practically all. Do not be afraid to show your ignorance. You will find that men will think the better of you and will be eager to teach you and give you any desired information. Be willing to learn from anyone and everyone, even the lowest paid and most ignorant helper in the plant, if he has something worth while to impart. He may not be able to express himself in technical terms or elegant language, but as the result of doing the same thing day after day for a long period of time, he may know all that there is to be known about his particular job. Often, when looking for information in this way, you may have to listen to much that is foreign to the matter in mind or to what you already know, but be patient and do not let your informant know of these facts.

Acknowledging Errors and Giving Credit for New Ideas and Processes

Do not feel above those under you, or at least do not show that feeling; and it is better for the development of your character that you do not feel it. On the other hand, never so conduct yourself as to lose the respect that is due your position. There is the middle ground to be taken, and as a result the men will like and honor you the more. Always be quick to acknowledge your error and to take your share of any blame that should rightfully be yours. It is not criminal to make a mistake — the crime comes when the same mistake is made a second time. Whenever an error or accident happens in connection with your work, never rest content until you have found out the cause and the means of preventing it from recurring. Never fail to give credit for a new idea, a new process, a new tool, or a new machine, to whom it is due. Do not pass off as your own idea or your own work that of a man under you. You may "get away with it," to use a slang phrase, but it will cheapen your character and your better nature will resent it.

Never censure an employee in public, that is, before his or her fellow employees. Reprimanding is much more efficient when done in private. Never order a man in your employ to do anything or go any place that you would not do or go yourself because of the danger involved. In case it is necessary for such work to be done, call for volunteers, and have it plainly understood that the danger exists and that the service is voluntary. This releases you from any moral responsibility, and also from a legal one.

Approach every problem or argument with an open mind, absolutely unprejudiced and unbiased. Be thorough and exhaustive. If you are sent to obtain certain data, be sure that you cover every phase of the matter and obtain the requisite information concerning every detail. Such action demands study and forethought, but it is absolutely necessary to success. Develop the analytical mind and the all-seeing eye.

When you have written reports to make, see to it that they are intelligently, logically composed, and complete. Practice will accomplish much in this line, and do not get discouraged if first attempts are not all that they should be.

As you advance in your work, as I hope you will, do not so conduct your job that your plant or your department must close down if you are absent. Many executives have the idea that such a dependence is creditable to them, in that it proves how indispensable they are to the operation of the plant. They are greatly in error. Such action shows poor management and short-sightedness. Give the men under you proper responsibility in their work. If they are not capable of assuming this responsibility, then employ those who are capable.

Desks Should Be Kept Orderly

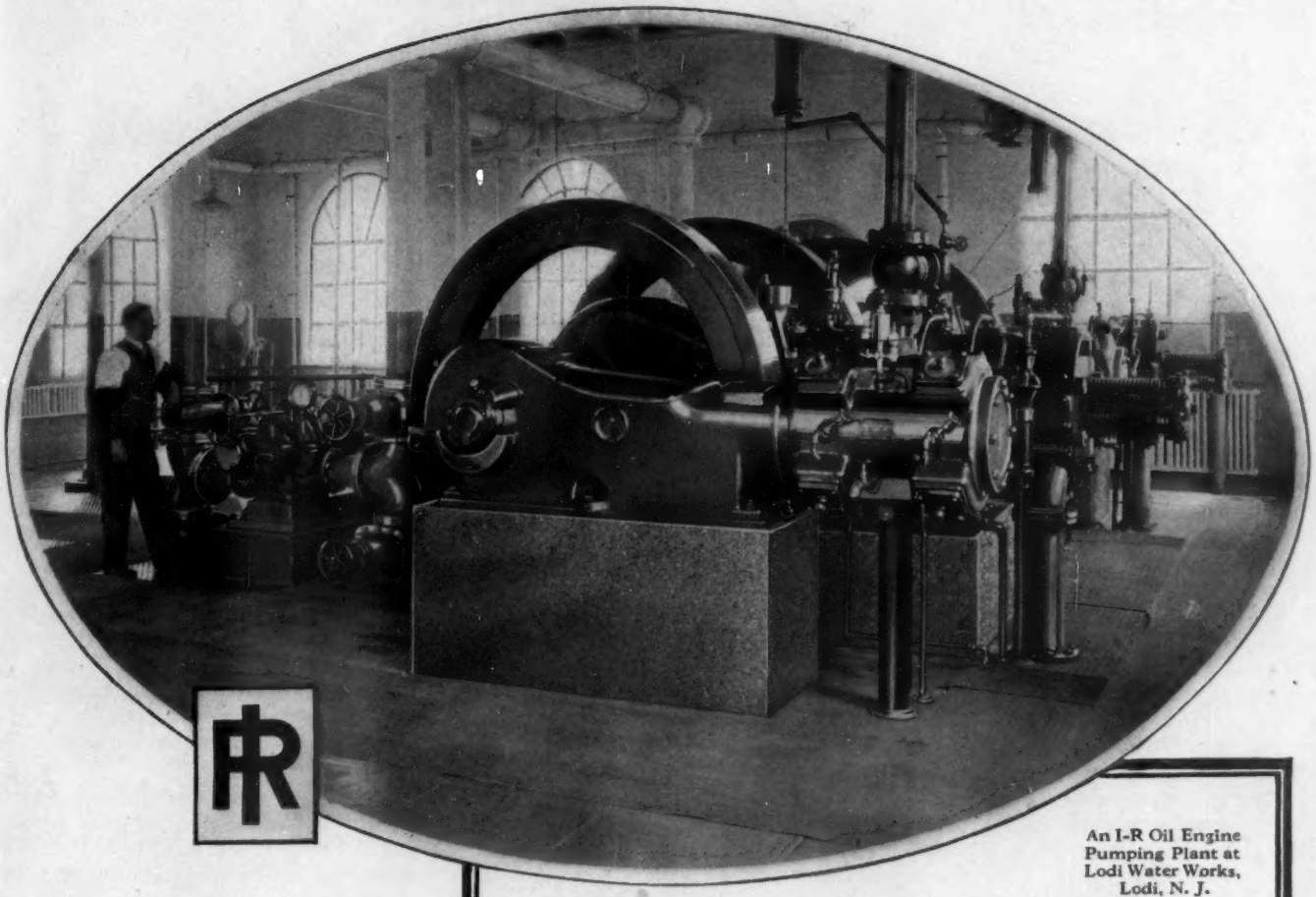
If you have a desk, see that the top, at least, is kept orderly and up to date. By this latter I mean do not have it cluttered with a mass of material that is not active. Use system in all things. Always carry a notebook of some kind in your pocket, in which to jot down the bit of information that you have picked up, the data to which you must refer, or the work that you must get started.

Keep in close touch with the progress and development of that particular industry with which you are connected. Do this in part by subscribing to at least one technical magazine relating thereto, or if the company receives such magazines regularly, you can read those copies. Engineering science and industry are advancing rapidly and will gather even more speed in the next few years. The methods and reasonings of today will be superseded by those of tomorrow, and you must be up to the minute in order to achieve success. Keep a reference file of magazine clippings such as you may consider worth retaining. You will often find this useful.

Promises, Once Made, Should Be Kept

In making promises to complete a job at a determined time, make the time later rather than earlier than what you think you can do it in. That is, it is far better to finish the work in a shorter time than promised than to require a longer time. The first goes to your credit, the second is marked against you. But having once made your promise, do everything in your

(*Continued on page 144*)



An I-R Oil Engine Pumping Plant at Lodi Water Works, Lodi, N. J.

Selecting the Job and the Employer

As Commencement approaches, the college senior reflects on things past and looks forward to the future. He realizes that a man derives his greatest happiness in life from his family, his friends, and his work He is looking for employment with a concern whose integrity and stability match the high quality of its products.

Ingersoll-Rand has long stood as a leader among the manufacturers of compressed air machinery, pumps, condensers, mining and quarrying equipment, and oil engines. For fifty-five years it has been combining the latest advances in engineering with the most careful methods of manufacture—a policy of progress resulting consistently in products of the highest quality. It is continually broadening its field, and its customers are found all over the world.

Among the major factors which have contributed to the stability and success of the Company are: recognition of engineering talent, promotion of superior employees to the highest places in the organization, and a plan of industrial research that has kept its products abreast of the times.

INGERSOLL-RAND CO., 11 Broadway, New York City

Offices in principal cities the world over

INGERSOLL-RAND PRODUCTS

AIR AND GAS COMPRESSORS

ROCK DRILLS
DRILL SHARPENERS
PNEUMATIC TOOLS
TIE TAMPERS
CAMERON PUMPS
VACUUM PUMPS
CONDENSERS
AIR LIFT PUMPS
AIR HOISTS
OIL & GAS ENGINES

OIL-ELECTRIC LOCOMOTIVES

Ingersoll-Rand

Inspection Methods

(*Continued from page 118*)

it. If the tolerances specified are closer than are actually required, unnecessary expense will be incurred in meeting them; if they are too liberal, an unsatisfactory product will result.

Properly dimensioned component drawings not only give the inspectors directly the information they require, but also show the tool designer the holding points he must use in the design of the manufacturing equipment. Improperly dimensioned component drawings lead only to confusion.

The inspection of the product falls logically into two divisions: first, the process inspection, and second, the final inspection.

Process inspection operations should be considered in the same light as the other manufacturing operations. These should occur immediately after every machining operation that finishes an important functional surface. The tolerances established should be as liberal as conditions will permit, and should be rigidly enforced here. Nothing will do more to promote a high quality of product than the establishment of proper tolerances and their strict enforcement. Operations which are not meeting the specified requirements should be stopped at once and the set-up or tools should be corrected before proceeding again. The practice of piling up faulty parts until the production schedule forces them to be passed "on disposal" cannot be condemned too severely. If the established requirements are right, such a practice is gambling with the good name of the plant. If they are unnecessarily severe, they should be corrected. The main object of process inspection is to keep a close check on the set-up and operation of the manufacturing equipment and to cull out faulty parts as soon as possible after the defect occurs so as to save the expenditure of further effort on the production of unsatisfactory parts.

The final inspection should be handled in a more judicial manner. The object here should be to accept all parts that will function properly and to reject those that will not. If the process inspection has been properly carried out, this inspection would consist of functional tests only, with perhaps a visual inspection for general quality of workmanship. In the final inspection, minor and unimportant deviations from the specifications can be ignored, while they should not be permitted by the process inspection, because nothing should be left undone while the material is being shaped to size and form to make the product meet the specifications, while after the work has been completed, nothing should be scrapped that will be serviceable and entirely satisfactory in the completed mechanism. This may seem contradictory, but it should be apparent that there is a distinct difference between the nature and purposes of process inspection and final inspection.

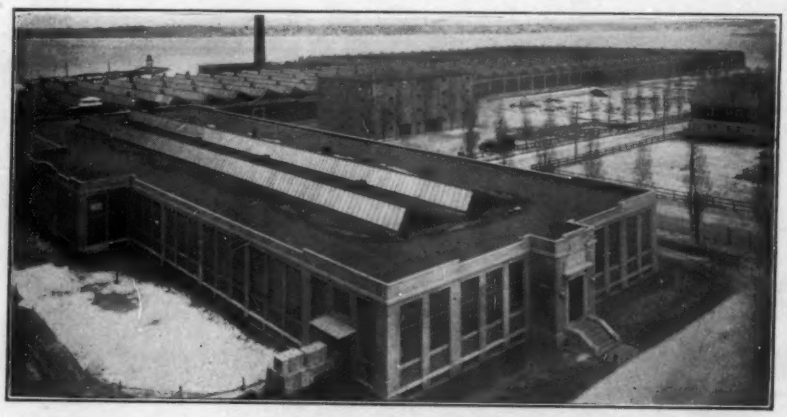
The natural and proper tendency in planning the inspection schedule on a new product is to provide means for checking the obvious and elementary mating surfaces. Every effort should be made to keep both the inspection operations and equipment as simple as possible. As found necessary by experience, additional inspection operations and equipment are added. Oftentimes such additional equipment is of necessity more elaborate than the original facilities provided. This is due to the fact that all of the simple measurements are provided for in the original schedule.

The best point of vantage to judge the effectiveness of the inspection methods is on the assembly floor. If the parts as produced assemble and function properly, it is complete evidence that all essentials are under proper control. If they do not, it is equally conclusive evidence that some further control is necessary. This does not necessarily mean that additional inspection is required. Oftentimes a minor improvement in the manufacturing equipment which makes it more reliable is the proper action.

Inspection equipment should be kept as simple and inexpensive as possible. One step to this end is the adoption and use of as many standards as possible for various parts, surfaces, and tolerances. Such a procedure results in many of the benefits and economies of quantity production where they would not otherwise be available. The more that different plants and industries agree on common standards, the more far-reaching these benefits become.

Any definite inspection system should be developed around its own particular product and manufacturing plant. The best inspection methods are so closely interwoven with the particular manufacturing methods employed that the use of any fixed system developed without regard to all factors involved would be not only ineffective but also unduly expensive. The best system of any sort is always the least that proves effective.

Gunite Process for Tunnel Lining. This new process has been used successfully for the lining of an irrigation tunnel. The lining varies in thickness from 18 to 30 inches. Due to the dryness of the mix, only light forms were required, and were left in place about 48 hours.—*Journal of Electricity*.



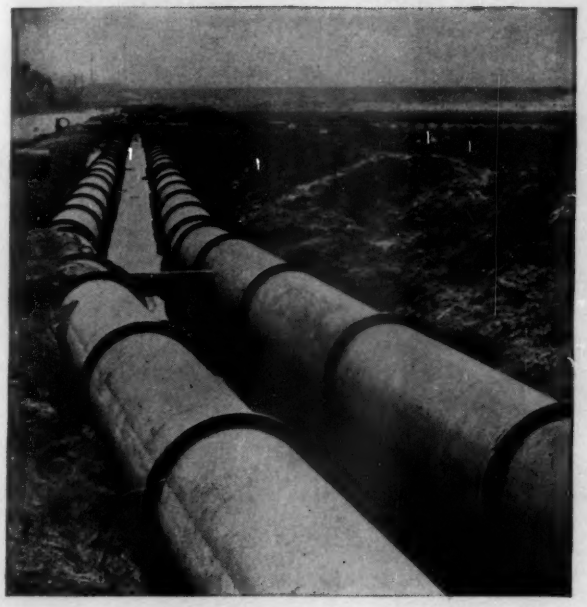
One of the finest textile mills in the world, built by Wm. T. Reed Co. Several repeat orders have been received from this firm

WILLIAM T. REED CO.

Building Construction

200 DEVONSHIRE STREET, BOSTON

We are organized and equipped for the efficient handling of mercantile and industrial building construction of all descriptions.



Resists Corrosion

THIS picture, taken in the salt marshes near Kearny, N. J., shows two lines of 30-inch Cast Iron Pipe replacing pipe made of other material. The alternate exposure to the action of salt water and air is a severe test.

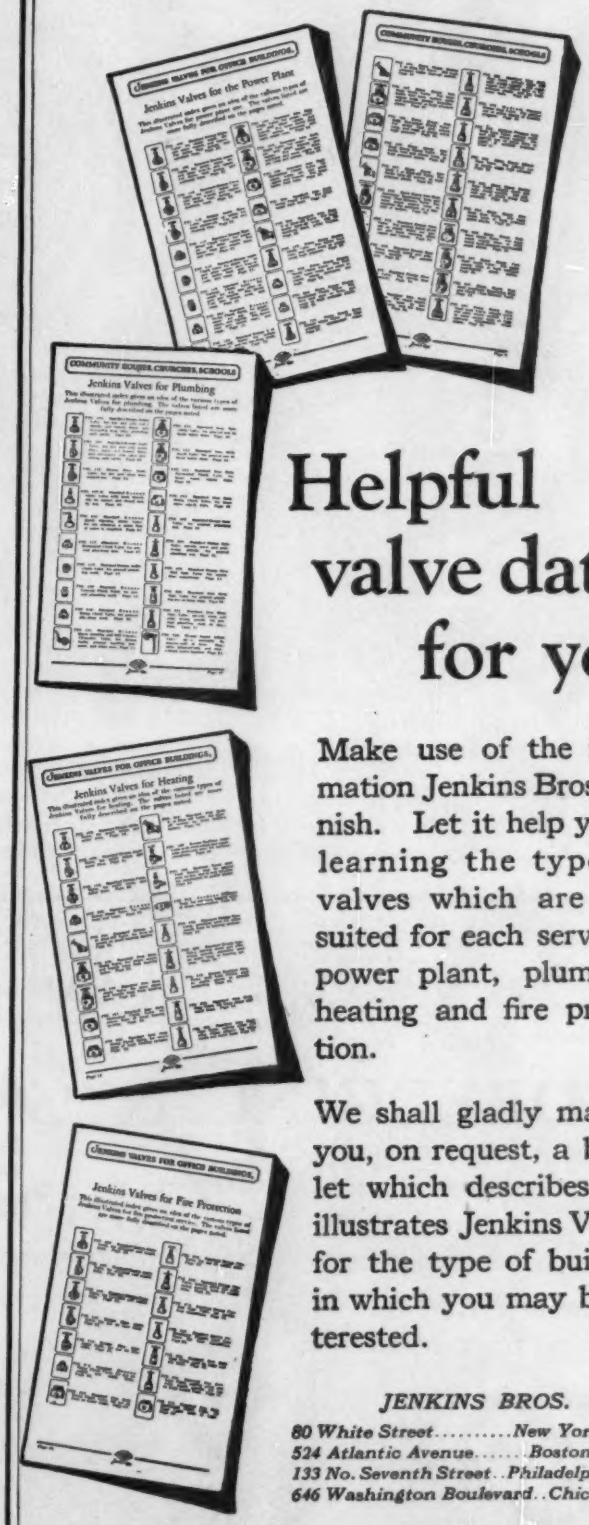
While the pipe shown in the picture is subjected to unusual corrosive influences, all underground pipe must be able to withstand corrosion to a greater or less degree. Cast Iron Pipe has this quality. It does not depend on its coating to resist rust; the material itself is rust-resisting. The first Cast Iron Pipe ever laid is in service today at Versailles, France, after two hundred and sixty years' service.

THE CAST IRON PIPE PUBLICITY BUREAU
Peoples Gas Bldg., Chicago

CAST IRON PIPE

Our new booklet, "Planning a Waterworks System," which covers the problem of water for the small town, will be sent on request

Send for booklet, "Cast Iron Pipe for Industrial Service," showing interesting installations to meet special problems


Jenkins Valves for the Power Plant
Jenkins Valves for Plumbing
Jenkins Valves for Heating
Jenkins Valves for Fire Protection

Helpful valve data for you

Make use of the information Jenkins Bros. furnish. Let it help you in learning the types of valves which are best suited for each service—power plant, plumbing, heating and fire protection.

We shall gladly mail to you, on request, a booklet which describes and illustrates Jenkins Valves for the type of building in which you may be interested.

JENKINS BROS.
80 White Street.....New York, N. Y.
524 Atlantic Avenue.....Boston, Mass.
133 No. Seventh Street..Philadelphia, Pa.
646 Washington Boulevard..Chicago, Ill.

JENKINS BROS., LIMITED
Montreal, Canada London, England

The above are valve index pages from Jenkins Booklets

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

The Trend of Modern American Architecture

(*Continued from page 117*)

part (meaning by structure the relation between plan, section, and elevation), is the reaction of the people to design and their education for the beautiful. It is well known that architecture always follows the economic and social periods. Good periods of architecture follow good financial periods. If the people want good architecture the architects will design it for them. If the people do not know what good architecture is, the architects will not do good architecture. At the present time, with the wealth in this country, and with the automobile, more interchange of ideas takes place, and also more people are traveling to other countries and seeing what has been done. We are at the period in our development now when the average person wants a certain period slavishly copied, or some particular building or style used. For instance, an English cottage may be taken as an example of a twenty-room house, or a little Cape Cod house developed into a modern fifteen-room dwelling, or Colonial architecture applied to a thirty-story office building. It will be necessary for this country to go through this copying stage, changing it slowly, as all other styles have done, until we know and have in us good proportion and good design, built according to the social and economic development of our country.

For instance, I have just said excellent proportions. That is a matter of comparison, for the Greeks, Romans, the period of Gothic architecture, all had proportions and excellent ones, and all different. The American proportions will be still different when our architecture is developed.

What, then, is the trend of modern architecture? The word architecture I have used not merely as the surface decoration, often called design, but the expression in the building of its use, in its plans, section, and elevation. This trend, I believe, is in two directions, both acting at the same time, one towards the evolving of a building to fit modern needs, and second, a conscientious attempt to clothe these needs in a structural and dignified manner. This development is forging ahead just as fast as the architect's client and the people desire it, or as they are educated to it. There is no question but what certain buildings appeal to people more than certain others, and in some cases I know of good architecture being a financial return to the promoter. I feel that modern architecture is not now tending to any one definite style, nor is it necessary that it should, as the people of this country are not tending to one homogeneous mass, but certainly there is such a thing as modern American architecture. Find, for instance, a prototype for a modern office building, with its elevator equipment, or a modern hotel, or a modern theater or apartment house, or even a little bungalow of three rooms, in English, Gothic, Roman, or Greek architecture. It can't be done.

Architecture is not a fad, nor is it a bag of tricks. It is not the design of this or that style, but is a natural expression of the needs and life of the people it serves. When the needs of the people are determined and the life of the people stabilized, a style will follow, which style will take its course and have a true development.

BAY STATE
DREDGING & CONTRACTING CO.
Contractors

River and Harbor Improvements
Sea Walls
Breakwaters
Heavy Masonry Construction
Concrete and General Contracting

View showing discharge end of 27" hydraulic pipe line, now completing the fill for Savin Hill Approach of Old Colony Boulevard across Dorchester Bay for State of Massachusetts. Fill is being made at rate of 10,000 yards per day.

OFFICE
EAST BOSTON, MASS.
62 CONDOR STREET

TELEPHONES
East Boston 1834 *and* 1835

GORHAM H. WHITNEY, *President*
JAMES E. CASHMAN, *Treasurer*
DAVID J. WHITE, *Gen'l Manager*

Filling the joint with asphalt mastic filler

TWO styles of modern granite blocks — one the standard 5″ depth. The other, the wider, shallow block, from 3½″ to 4″ deep — ideal for bridges and medium traffic generally. Note accurate, smooth finish of wearing surfaces.

The modern, close, narrow joint, filled with ***mastic*** — joint ½″ to ⅜″ wide. Such joints mean ***quiet*** and ***smoothness*** in a modern granite block pavement.

The stress of traffic will not — cannot — "shove" a granite block pavement. The slight wear of traffic on granite blocks does not manufacture dust or dirt — nor is ***mud*** formed, for no dust, dirt, or refuse lodges in the smooth, even, sealed, narrow mastic joints between the smooth blocks.

Oil is unnecessary. A modern granite block pavement, with its close, waterproof mastic joints, is as smooth, clean, and sanitary as a piece of rock — and as permanent.

Modern granite block pavements have smoothness, quietness, non-slipperiness, and eternal durability.

The Granite Paving Block Mfrs. Assoc. of the U. S. Inc.

31 State Street, BOSTON, MASS.

Representing The World's Greatest Granite Quarries

GRANITE PAVING BLOCK MANUFACTURERS ASSN OF U.S. INC.

GRANITE·LIVES·FOREVER

Finding an Anti-knock Material

(*Continued from page 119*)

crystalline iodine, so that piece of luck No. 2 had the value of a 2000 to 1 shot.) The crystalline iodine dissolved nicely in the fuel, yielding a dark brown fluid, and was immediately tried in an engine which had been knocking violently on the untreated fuel. The knocking ceased, the motor ran smoothly, and developed more power and efficiency than we ever had been able to obtain from any motor operating on this same fuel. Consequently the theory stood proved, and like Columbus we believed we had discovered our short cut to "India"; but within the next hour we had obtained some oil soluble dyes and had dyed much fuel to even deeper and darker shades than the iodine ever could, but the behavior of the fuel was not influenced in the slightest degree by these other materials, so we realized that we had not landed on the shores of "India," but merely had discovered the sand-bar of "San Salvador."

Time passed. No other theory that we could spin would lead us to new discoveries. Iodine appeared to be the only material that possessed the property of stopping a fuel from knocking, and there were many objections to the use of iodine, among which cost was not the least.

One day we decided that it was practically useless to continue these researches further, but that before entirely abandoning this project we would devote two weeks in trying, without theorizing, any and all materials that we could lay our hands on; and having decided to stop thinking and give luck a further opportunity to express itself, we discovered a new anti-knock material within the next two days. This material was aniline oil, and was so nearly commercial that two years were spent in trying to overcome its two objections, cost and unpleasant odor in the motor exhaust.

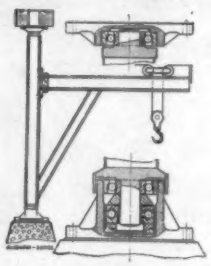
About this time Doctor Victor Lehner announced the remarkable properties of selenium oxachloride as a solvent. This material appeared to possess interesting possibilities as a reagent for analyzing gasoline, so we obtained a pound of this oil, and since our previous experiences had taught us that predictions were most unwise as to whether a material was or was not an anti-knock material, we had adopted the rule of trying everything new that we received, so that selenium oxachloride was tried within fifteen minutes after our bottle of the same was received. It was a more powerful anti-knock material than we dreamed was in existence, but still possessed an impossible characteristic for commercial use. Taking our courage in our hands, so to speak, we once more dared to theorize, and from here on our theories began to bear fruit. We theorized that if selenium was good, tellurium should be better, and the use of diethyl telluride confirmed this deduction, but it still possessed a characteristic that would bar it from decent society. Tellurium compounds possess the most obnoxious odors themselves and have the ability to make anyone who comes in contact with them smell the same way, so that irrespective of cost or any other advantage it might possess, its use was utterly impossible of practical application.

We now formulated a set of empirical rules for predicting the anti-knock properties of compounds. In many cases we knew the effect would be extremely slight, too slight indeed to be detected by ordinary means of measurement. It was therefore necessary to develop new methods of measuring detonation, and the result was an instrument known as the Bouncing Pin, which could detect the most minute influences of foreign substances in gasoline. With this instrument and our empirical rules, we explored, systematically, the periodic table of elements. We plotted curves of the anti-knock property against atomic numbers in the various groups of elements, and at the completion of this investigation we felt that our data were as complete as we reasonably could expect. With these data before us we were in a position to analyze the value of any compound of any element and determine which would have the maximum value in commercial application. A number of compounds were then selected, prepared, and motor tests conducted. The results showed that tetraethyl lead was the best material that we could apply commercially.

True, tetraethyl lead is a poisonous material, but an investigation of its toxicity proved that it was no more poisonous than many other articles of commerce. Also a small amount of lead is emitted in the exhaust of a motor burning gasoline containing

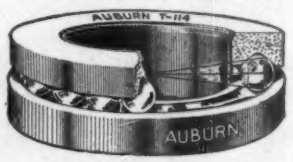
(*Continued on page 142*)

JIB CRANES
Operate Smoothly with
AUBURN THRUSTS



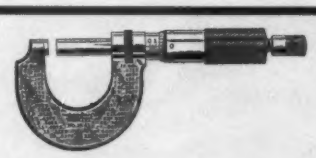
Jib Cranes and other slow-moving machine parts are turned easily under the heaviest loads when Auburn Ball Bearings are installed to reduce the starting friction.

Steel, Brass, and Bronze Balls
Send for Data Sheets

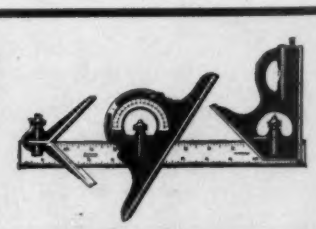


AUBURN BALL BEARING CO.
44 Elizabeth St., ROCHESTER, N. Y.

LUFKIN
TAPES
RULES

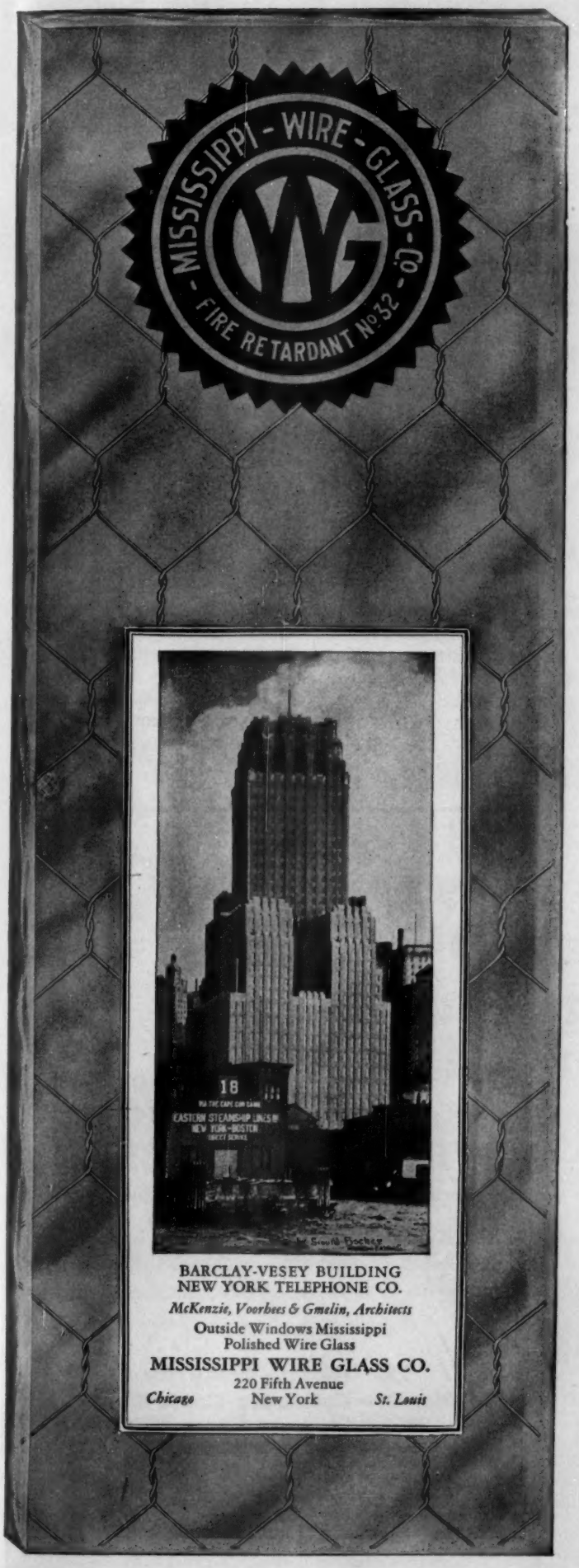


LUFKIN
SMALL
TOOLS

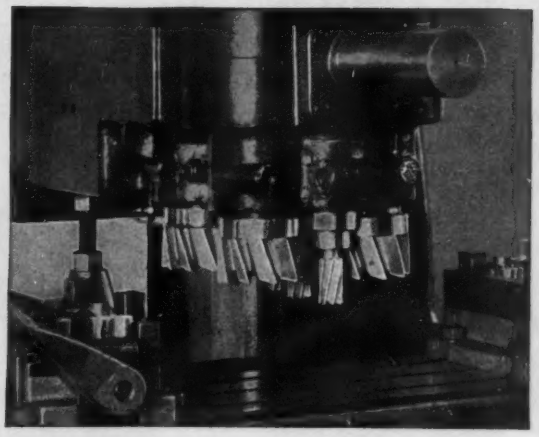


DISTINCTIVE IN QUALITY
Made in patterns best suited to every class of work
SEND FOR
Cat. No. 11 — Tapes and Rules Cat. No. 4 — Tools

THE LUFKIN RULE CO. SAGINAW, MICHIGAN
NEW YORK WINDSOR, CAN.



BARCLAY-VESEY BUILDING
NEW YORK TELEPHONE CO.
McKenzie, Voorhees & Gmelin, Architects
Outside Windows Mississippi
Polished Wire Glass
MISSISSIPPI WIRE GLASS CO.
220 Fifth Avenue
Chicago New York *St. Louis*

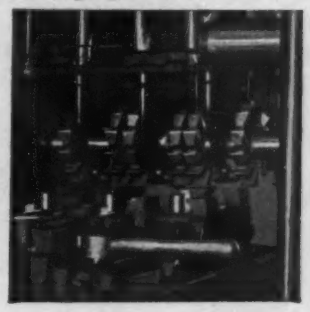


More cuts per minute by adding more good cutters

IN the endeavor to achieve quicker and more economical methods in milling, the number of cutters used in a single set-up has tended to increase. This is particularly true of automotive shops where high production is the watchword.

Two automotive jobs are shown. Above is a Brown & Sharpe Automatic Milling Machine which fairly bristles with cutters. Eight Brown & Sharpe cutters—four Coarse Tooth End Mills and four Spiral Shell End Mills—are used. Below is a view of an operation on a Brown & Sharpe No. 13B Plain Milling Machine in which six Brown & Sharpe Coarse Tooth Side Milling Cutters and three Spiral Shell End Mills (in back) are used.

The advantage of such operations depends largely on the durability of the cutters. Too frequent stops for sharpening or changing cutters are disastrous to the production schedule. As the best insurance of durability, long life, and long service between sharpenings Brown & Sharpe Cutters were chosen for these and many similar jobs.



BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

Anti-knock

(*Continued from page 140*)

tetraethyl lead, but calculations indicate that even though every automobile in the country used such a fuel the lead dust in the exhaust would constitute no menace to health in comparison to the carbon monoxide hazard already existing; and when it is borne in mind that the use of tetraethyl lead in gasoline permits of a very decided reduction of the total quantity of carbon monoxide ejected by a motor in producing a given amount of mechanical work, the health balance is in favor of the use of tetraethyl lead.

The sale of tetraethyl lead in gasoline to the motoring public for use in present-day motors in overcoming "spark" knocks has met with an enthusiastic reception by the users of it, and the day is rapidly approaching when a sufficiently universal distribution of this material will have prepared the way for the higher economies of the future.

The S. S. Malolo

(*Continued from page 113*)

The propelling machinery consists of two sets of turbines each driving one propeller.

Steam is supplied by twelve oil-fired Babcock and Wilcox water tube boilers arranged in two adjacent watertight compartments. The boilers have approximately 55,700 square feet of heating surface and 11,100 square feet of superheating surface. The working pressure of the boilers is 280 pounds and the superheat 100 degrees. Individual uptakes from each of the six boilers in each fire room unite to form one breeching, and above the top of the bulkhead which separates the fire rooms, and which is about 45′ above the base line, these two unite into one stack which extends to about 120′ above the keel. The outside dimensions of the outer stack, which is elliptical, are 28′ and 17′.

Two main feed pumps and four auxiliary feed pumps are provided. Twelve motor-driven forced draft blowers are fitted, one blower serving a boiler. Mechanical atomizing fuel oil burners are fitted to the boilers.

The propelling units are in two engine rooms, each unit of which can be operated with the other engine room flooded. Each unit consists of one H.P. turbine, one 1st I.P., one 2nd I.P., and one L.P. turbine, and one cruising turbine. These turbines drive the shaft through two separate sets of reduction gears. The turbines are of the Parsons type.

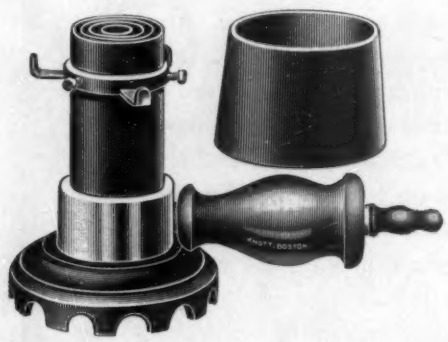
When running for long periods at reduced speeds, the cruising turbine is connected to each main high pressure turbine through a clutch, which can be disconnected when the vessel is operating under high-speed schedules.

The reduction gear ratio is approximately 12 to 1. At full power of 25,000 S.H.P. the propeller turns per minute will be approximately 121.

Line shafting is in general 20′ outside diameter and has a 6¾″ axial hole.

Two main condensers, each of about 16,000 square feet of cooling surface, will be installed. Scoop circulation of cooling water is provided. At low ship speeds, turbine-driven circulating pumps are available.

Over the two engine rooms there is a dummy stack of the same size as the boiler stack and serving as a ventilator for the engine rooms.



Double Air Current

K KNOTT

WHERE extreme heating speeds are required, there is no substitute for this *double* air current burner listed on page 46 of Catalogue 30C.

Quiet operation is a result of its doubled combustion area. It will not strike back.

Diameter of burner tube 35mm. No. C4040 complete as illustrated, with burner guard.....$9.75

L. E. KNOTT APPARATUS COMPANY
CAMBRIDGE, MASSACHUSETTS

SINCE 1895

The Standard for Rubber Insulation

OKONITE
TRADE MARK

RUBBER COVERED AND VARNISHED CAMBRIC

WIRES and CABLES

are made with especial regard for Quality

All OKONITE products are carefully inspected and tested at each step in the manufacturing process so as to insure a perfect finished result.

Full details in Handbook—Send for it.

The Okonite Company
The Okonite-Callender Cable Co., Inc.
Factories, PASSAIC, N. J. PATERSON, N. J.

Sales Offices: New York, Chicago, Pittsburgh, St. Louis, Atlanta, Birmingham, San Francisco, Los Angeles, Seattle

OKONITE

Pettingell-Andrews Co., Boston, Mass.
Novelty Electric Co., Philadelphia Pa.
F. D. Lawrence Elec. Co., Cincinnati, O.

Canadian Representatives: Engineering Materials Ltd., Montreal
Cuban Representatives: Victor G. Mendoza Co. Havana

HIGH ALUMINA FIRE BRICK

THE use of "KRUZITE" and "MIZZOU" high alumina fire brick for extreme furnace conditions is desirable in super power plant work. May we send samples?

A.P. GREEN FIRE BRICK CO.
MEXICO, MISSOURI

Engineer's Letter to His Son

(*Continued from page 134*)

power to make good that promise. The same principle applies in estimating the cost of a job. It is better to overestimate than to underestimate.

In closing I can do no better than to urge you to be efficient, at the same time recalling to your mind the summing-up of Dr. Frank Crane of his definitions of "efficiency." He says:

"It is the measure of a man, the size of his soul.

"It is the ability to use his passions, likes, dislikes, habits, experience, education, mind, body, and heart — and not to be used by these things.

"It is self-mastery, concentration, vision, and common sense.

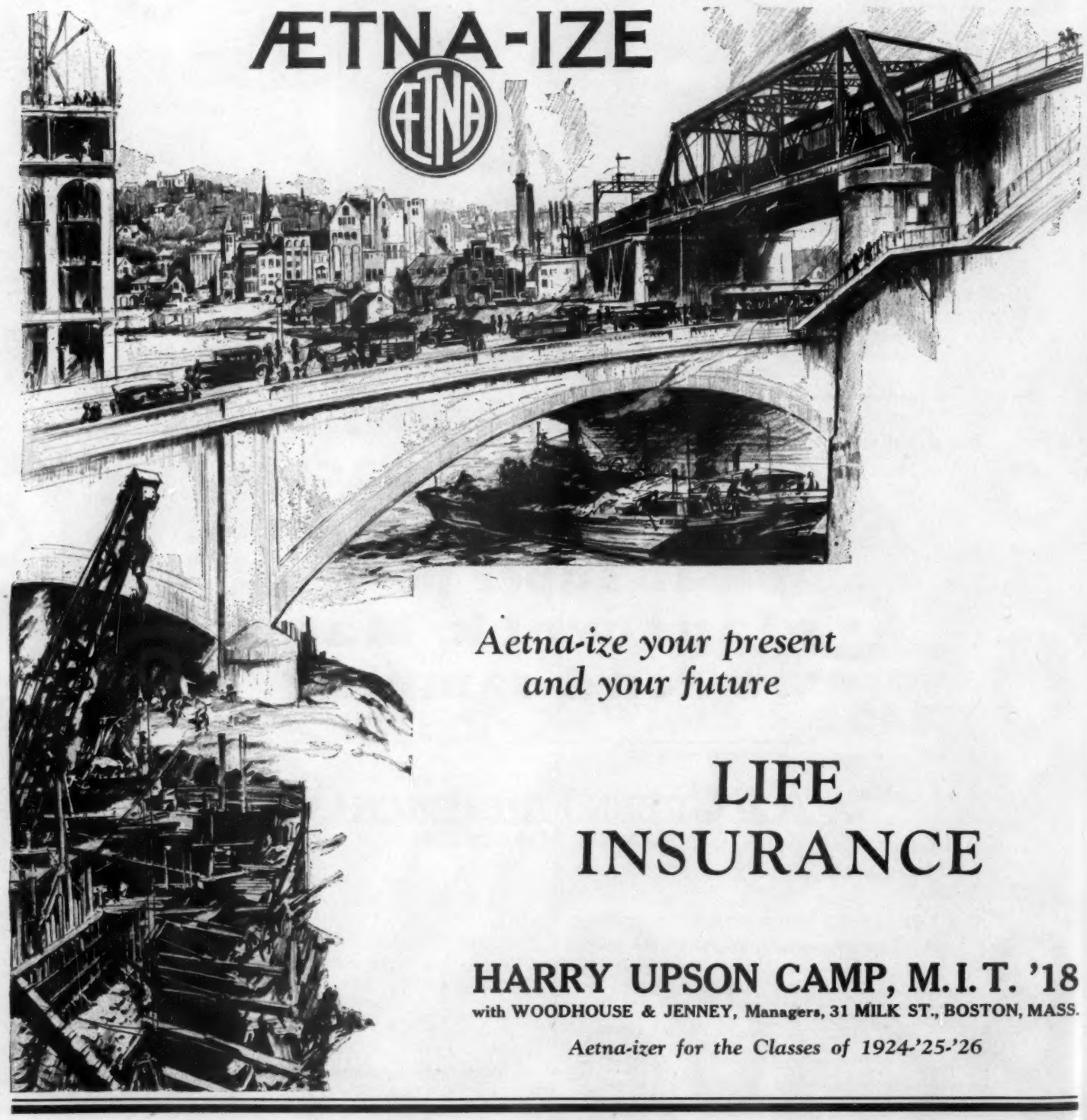
"It is the sum total of all that's in a man."

Once more, my son, I say "Be efficient."

COLIN ARTHUR.

Quincy, Mass.

The Structural Iron and steel in the Madison Square Garden, which was recently demolished, was found to be in a perfect state of preservation. This building was over thirty years old, and no special care had been taken for the maintenance of the framework, except where it was enclosed in the brickwork. The results indicate that with proper maintenance a steel frame building may be expected to endure indefinitely.



Aetna-ize your present and your future

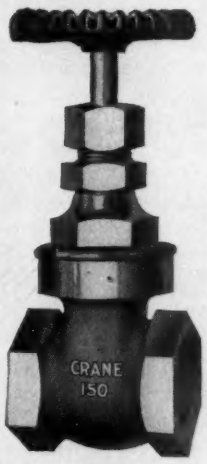
LIFE INSURANCE

HARRY UPSON CAMP, M.I.T. '18

with WOODHOUSE & JENNEY, Managers, 31 MILK ST., BOSTON, MASS.

Aetna-izer for the Classes of 1924-'25-'26

. . CRANE VALVES . .



Wedge Gate Valve
NO. 437

Subjected to hydraulic pressures closed from 700 to 3000 lbs. and open from 1000 to 3000 lbs. without leaking. Recommended for steam pressures up to 150 lbs.

Through Your Working Career

When commencement is over and your working days begin, Crane stands ready and glad to advise with you regarding numberless problems of equipment. Crane will co-operate with you as it has since 1855 with the engineers who have preceded you. It was Crane that first began the systematic testing of metals to determine their reaction under varied conditions of pressure and temperature. It pioneered in the chemical control of raw materials. Into the valves, fittings and piping materials now offered, 71 years of experience has been put. This experience is devoted to your service.

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Fifty-five Cities

National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton, Montreal and St. Johns, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, HAVANA

CRANE LIMITED: CRANE BUILDING, 386 BEAVER HALL SQUARE, MONTREAL

CRANE-BENNETT, LTD., LONDON

CIE CRANE: PARIS, BRUSSELS

KEYSTONE COPPER STEEL

Steel Sheets that Resist Rust!

The destructive enemy of sheet metal is *rust*. It is successfully combated by the use of protective coatings, or by scientific alloying to resist corrosion. Well made steel alloyed with Copper gives maximum endurance. Insist upon

KEYSTONE
Rust-Resisting Copper Steel
Sheets

Black and Galvanized

Keystone Copper Steel gives superior service for roofing, siding, gutters, spouting, culverts, flumes, tanks, and all uses to which sheet metal is adapted—above or below the ground. Our booklet *Facts* tells you why. We manufacture American Bessemer, American Open Hearth, and Keystone Copper Steel Sheets and Tin Plates.

Black Sheets for all purposes
Keystone Copper Steel Sheets
Apollo Best Bloom Galvanized Sheets
Apollo-Keystone Galvanized Sheets
Culvert, Flume, and Tank Stock
Corrugated Sheets
Formed Roofing and Siding Products
Automobile Sheets—all grades
Electrical Sheets, Special Sheets
Deep Drawing and Stamping Stock
Tin and Terne Plates, Black Plate, Etc.

Our Sheet and Tin Mill Products represent the highest standards of quality, and are particularly suited to the requirements of the mining, engineering, and general construction fields. Sold by leading metal merchants. Write nearest District Office.

American Sheet and Tin Plate Company

General Offices: Frick Building, Pittsburgh, Pa.

DISTRICT SALES OFFICES

Chicago Cincinnati Denver Detroit New Orleans New York Philadelphia Pittsburgh St. Louis

Pacific Coast Representatives: UNITED STATES STEEL PRODUCTS CO., San Francisco Los Angeles Portland Seattle

Export Representatives: UNITED STATES STEEL PRODUCTS CO., New York City

The 1926 Graduate — Planning a Career

(*Continued from page 132*)

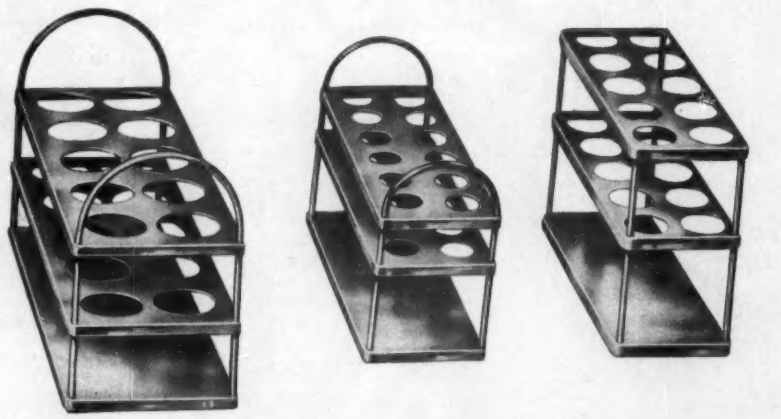
South now rivals and may even surpass the other textile districts. North Carolina is a state which is making rapid progress. Both in Georgia and Alabama as well, as in other Southern states, the development of super-power is a great factor. Texas also has great natural resources, and Florida is by no means done yet.

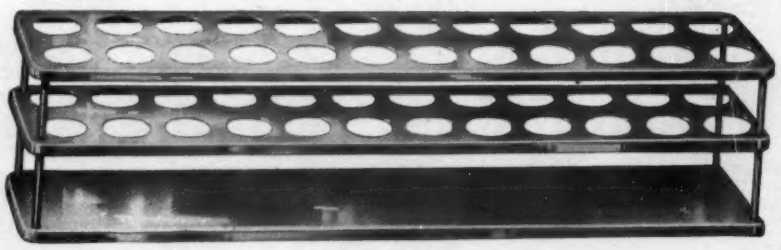
Moreover, the graduate may want to consider not merely the broader regional divisions, but also the relative opportunities offered by individual cities. In this connection, some extremely interesting work has been done by Dr. Raymond Pearl. I find the formulas which he has developed for entire countries may be adapted with considerable success to the study of individual cities. Likewise, a very valuable compilation of articles by other students of this subject has been brought out by the Pollak Foundation, under the direction of William Trufant Foster. I cannot imagine a graduate who will make a choice of locality — this choice perhaps a turning-point in his entire career — without availing himself of this wealth of analytical work.

Yes, let me say that the technical graduates of the future should be more successful than they have ever been. Remember that during the Great War the engineer in mental tests is said to have surpassed even lawyers and other professional men. Let him, however, employ his ability where it will perform a needed service. There the rewards will come. Let him select, also, a company which is of undoubted standing and backed by responsible men. There is a tendency to concentrate upon the problem of selecting an industry, with too little study of the individual concerns within the industry. Remember that a good concern in a poor industry may offer better opportunities than a poor concern in a good industry! Therefore, my previous remarks are made on the express condition that the choice of a business is only 50 per cent of the problem; the remaining 50 per cent of the problem has to do with the choice of the individual concern.

Associate yourself with some concern where the owners or controlling interests are men of character. In this way only can you get a square deal and be at your best. Absentee ownership is a poor thing. Get into some business where the powers that be are honest and straightforward and working day and night for its success, and then seek to get acquainted with them and try in every way to co-operate for a better business. Don't waste your time with companies or men who insist on an antiquated labor or personnel policy. If character and a humane and progressive management policy are lacking in the executives, have nothing to do with them. Strive constantly to put your firm on a higher plane in every way. If the graduate will follow the foregoing fundamental suggestions he will not long continue in a subordinate position. He will become an executive or owner of a business which is of untold benefit to the community, and which will bring to him the inevitable rewards of service.

Sheet Metal Specialties





Copper Test Tube Racks

THESE racks are invaluable for the bacteriological or biochemical laboratory. They serve the double purpose of either substantial test tube supports, or racks for immersion of Wasserman or other serological tubes in hot water baths. They are so designed that the tubes are always held upright and the contents visible.

PETER GRAY & SONS, Inc.

Manufacturers of Sheet Metal Specialties since 1878

Third and Binney Streets - East Cambridge, Mass.

Principles and Practice of Industrial Distillation. By E. Hausbrand. Translated from the fourth German ed. by E. Howard Tripp. London: Chapman & Hall; New York: John Wiley & Sons, 1926. 300 pp.

This is the first translation into English of a work that has long been the standard treatise on distillation in Germany, and has been highly valued in other countries. The book deals with the principles underlying the fractional distillation of liquid mixtures, and does not enter into details of construction of plant or apparatus. About 140 pages are devoted to tables of calculations and charts.

A GLIMPSE INTO YOUR FUTURE

MANY discerning engineering students are preparing themselves for future promotions *now* by reading The Explosives Engineer, regularly. And they are finding that this foresight does not involve arduous effort. Anyone wishing to learn more about mining, quarrying and construction will derive pleasure as well as profit from the carefully edited, authoritative articles and from the many photographs, drawings, paintings, and other illustrations. Prove this for yourself by writing for a free sample copy.

The Explosives Engineer is devoted to the technology of drilling, blasting, loading and transportation of coal, ore and stone. It is edited by engineers; many of its articles are written by experienced, well-informed operating executives. Each issue contains a bibliography of everything published in the technical press of the world, relating to drilling and blasting.

For less than three cents a month you can supplement your classroom instruction with this wealth of useful information from men who are now occupying the jobs to which you will some day aspire.

Just pin your check or a dollar bill to the coupon. You will then receive The Explosives Engineer for the next *Three Years.*

THE EXPLOSIVES ENGINEER

WILMINGTON *Published Monthly* DELAWARE

THE EXPLOSIVES ENGINEER,
941 Delaware Trust Building,
Wilmington, Delaware

Enclosed is one dollar for my three years' subscription to The Explosives Engineer, starting with the current issue.

Name_____

Street_____

City_____ State_____

Note: For four subscriptions in addition to your own, we will send you free four reproductions in full color of W. D. White's oil paintings of Mexican or Arizona mines and miners. They make corking decorations for an engineer's room.

Some Unusual Marine Accidents

(*Continued from page 115*)

and on a bid of $39,500. At the present period such repairs would cost roughly three times as much. The badly distorted steel plating and frames, weighing about 100 tons, brought the small sum of $75 as junk.

In 1907 the *S. S. Suevic*, a large 550-foot White Star Line freighter, went ashore on the Lizard, a treacherous rocky point off the southwest coast of England, located near many steamship lanes. While she was a slow vessel, her bow struck hard, and thus, due to the locking effect of the jagged rocks, she resisted all attempts to move her.

The salvage company, seeing that it was impossible to refloat the complete ship, and realizing that the after part was practically afloat, proceeded to cut the stern and midship section of the ship, containing the expensive machinery, clear of the badly damaged bow. In those days the acetylene cutting torch had not been developed, so the salvors employed dynamite to separate the two portions. When finally, at the section chosen, all the side and bottom plating was cut, and only the main deck remained, the stern portion rose and dropped with the ocean swell, and hence indicated that it was water borne. Towboats now took hold of the *Suevic's* stern, and with the final severing of the main deck they towed the midship and aft section stern foremost to Southampton for repair. Besides the towing tugs, two tugs were used astern to steer the hulk. The bow section remained pinnacled, and after being stripped of equipment lay abandoned.

Next, the insurance underwriters commissioned the builders of the *Suevic* to construct a new bow to replace the old, which was 185 feet long and weighed some 3000 tons. They constructed this portion like an ordinary ship, i.e., on a sloping building slip on shore. The builders had to study the stability of this odd wedge-shaped section and properly ballast it.

The two sections were now docked in their correct relative positions in a graving dry dock at Southampton. This necessitated great care on the part of the dock master, as lack of alignment of the two sections by one half an inch would show up when connecting them with the shell plates. Alignment in this case was assisted by bolting wooden guide battens (long timbers of about 10 inches by 10 inches scantling) to the shell of the after portion and extending beyond that section so the fore body was guided into place when the two sections were drawn together.

The repairers completed their work by fitting and riveting new shell plating at this section. In "Lloyd's Register of Shipping," a book which, like the "American Bureau Record," contains an abbreviated life history of all important vessels, the only notation of this repair is the following — "Rebuilt 1907."

A very unusual accident which necessitated great ingenuity on the part of the ship repairer was that of the *S. S. Curaco*. This vessel, then steaming toward the Northwest Arm, an inner harbor of Halifax, to join other vessels there ready for convoy, was stern to and 100 feet away from the *S. S. Mont Blanc* when the latter, loaded with T.N.T., blew up in December, 1917.

The explosion caused an almost mountainous wave, which rapidly traveled from the location of the *Mont Blanc* and resulted in much damage to all vessels in the vicinity. This wave

(*Continued on page 150*)

TECHNOLOGY BRANCH

76 Massachusetts Ave., Cambridge, Mass.

This is the place to which all Technology men instinctively turn when seeking technical and scientific books

We have an arrangement with the two leading publishers of books along these lines to send us copies of all the new books they issue immediately upon publication. The publishers we refer to are John Wiley and Sons Co. and McGraw-Hill Book Co.

Our shelves are always open for your inspection and you are welcome to look them over.

Technology Branch

HARVARD CO-OPERATIVE SOCIETY

U·RE·LITE

U-Re-Lite is not an ordinary safety switch or circuit breaker. It is The I-T-E Circuit Breaker in the specially constructed steel box. It is the only absolute protection against overloads, short circuits, and damaged electrical equipment. It is built by manufacturers who, for 36 years, have held the reputation of pioneers and leaders in electrical protective devices.

Safeguarding Electrical Equipment

To every industry in the world that uses electricity and electrical machinery, U-Re-Lite is a vital asset for the savings and protection it affords.

The most reliable insurance against loss of time, interrupted production and damage to valuable electrical equipment is

U·RE·LITE

U-Re-Lite is primarily a device that protects electric motors, lighting and power circuits from overloads and *short circuits*. It is an electric safety valve. An overload trips it open; a twist of the handle ON THE FRONT of the box restores service. Do not confuse it with ordinary circuit breakers—U-Re-Lite is *The I-T-E Circuit Breaker in the Steel Box*; sturdily built, rugged in design, Cutter-made, Cutter-guaranteed.

U-Re-Lite, once set and *locked* by the man in charge, cannot be tampered with. It will break a current at least 100 times as great as its rated capacity. U-Re-Lite has been fully tested and approved by the Underwriters' Laboratory for use without any fuses in the circuit it protects. Its range of sizes makes it adaptable to practically every size of motor in the average plant.

THE CUTTER COMPANY
ESTABLISHED 1888—PHILADELPHIA

Cutter Engineers have set down their most valuable knowledge on Electrical Protection—based on 36 years of wide engineering experience—into a fully illustrated, bound Handbook that every industrial executive and plant engineer should have in his possession. It is yours for the asking.

* * *

1. U-Re-Lite is absolutely fool-proof. Once closed, it stays closed until the exact current value trips it open.

2. U-Re-Lite is built to last. Its mechanical construction is perfect. Cost for repairs is negligible, if any.

3. U-Re-Lite has been passed by the Underwriters' Laboratories for use *without fuses* of any kind in the circuit.

4. U-Re-Lite has *never* failed to break a short circuit.

5. U-Re-Lite is reset by a twist of the handle *on the front* of the box—first to the left, then to the right, turn the handle, and U-Re-Lite

When writing to advertisers please mention the Tech Engineering News

CUTTER

U-RE-LITE ⁂ I-T-E CIRCUIT BREAKERS

M

Unusual Marine Accidents

(*Continued from page 148*)

buckled the *Curaco* locally at the center, so when the writer saw her the draft amidships was 16 feet, at bow 7 feet, and at stern 9 feet 8 inches. Thus the draft amidships due to this buckle was some 8 feet more than designed. The dotted lines of the figure show quite plainly that all distortion occurred directly amidships and both bow and stern were all right. Naturally, the vessel in this shape was worthless, as she would break in two if subject to heavy weather. In fact, her master temporarily beached the *Curaco* in Halifax Harbor to prevent her sinking.

As the explosion badly damaged the dry dock at Halifax the *Curaco* later was floated and towed to New York for reconditioning. To repair the *Curaco* it would be necessary to make the keel straight and renew all structure in way of the buckle. This was carried out in the graving dry dock of the Robins Dry Dock and Repair Company. The keel blocks were arranged in the ordinary manner, that is, so their tops lay in the same horizontal plane, and extra blocks were fitted amidships where the pressure would be greatest. Following the usual procedure, after the vessel had entered the dock and was properly centered, the floating caisson or gate and side shores were put in position. These last are used to hold the vessel upright while in the dock. Some water was then pumped out of dock, and soon the ship rested on the midship blocking. As more water was pumped out, acetylene torches progressively cut the ship's plating on each side in way of the buckle, thus allowing the ship's ends to drop and bear along the keel blocking. During this operation, which lasted seven hours, great care was used to guide the bow and stern as they approached the keel blocking so the structure would line up properly.

Acetylene torches were then employed to burn out all the rivets of the side plating in way of the cut. After fitting and riveting new plating, the *Curaco* was as strong and serviceable as formerly. A steel structure is especially adapted to such repairs, whereas a wooden ship is weakened by removing old fastenings and redriving new. For example, besides the cases of the *Suevic* and the *Curaco* a number of steel ships have been lengthened by cutting the hull in two, pulling the ends apart, and erecting new structure connecting the ends.

Besides the interesting repair of the buckled section of the ship, a number of bottom outside plates, buckled undoubtedly by the pressure wave accompanying the explosion, had to be taken off and renewed. As this accident occurred during the war period, very meager details were published, and the writer appreciates the notes given him by Mr. Donald F. Warner, M.I.T., 1922.

Detector for Defects in Rails. Engineers connected with the Japanese Government railways have recently perfected a portable device that permits the detection of internal fissures in rails laid in tracks. It is these fissures that are the cause of most rail failures. This does away with the necessity of taking up the track and transporting it to the apparatus.

This new apparatus, which is known as the magnetic defectoscope, utilizes the principle of the variation of the permeability of iron to show defects in it. A powerful electromagnet is supported above the rail on four rollers in such a way that the rail completes the magnetic circuit. Between the poles of the electromagnet is placed an exploring coil, composed of many turns of very fine wire, entirely insulated from outside disturbances by mica plates, with its ends bent down on each side of the rail. This coil is connected to a sensitive galvanometer with a mirror mounted on it. In the recording apparatus, a sliding block has a pointer which follows the reflected image of the light spot coming from the galvanometer mirror, and moves to and fro on a plate of frosted glass. The block carries a pen which traces a chart on a roll of paper.

When a faulty portion of the rail is passed over, a current is induced in the coil, and a sharp deflection is noted in the chart. Deflections are also caused by such things as abnormal internal stresses, and segregation of impurities, but the deflections caused by internal fissures are so sharp that they are easily distinguished from other defects. —*Engineering News-Record.*

A Tailless Airplane. A two-passenger airplane of revolutionary design has been built under the supervision of Capt. G. T. R. Hill, of the British Army. This airplane has no tail, and practically no fuselage back of the main wing surfaces. The wing span is 45 feet, of which 30 feet are fixed, while the other 15 feet are used to stabilize the plane. Small vertical surfaces, mounted below the wing surface near the extremities of the fixed portion, are used for steering. By simultaneous operation of both rudders, they can be used as a very effective air brake.

This plane has performed very well in the more than twenty trial flights already made. It has attained a maximum speed of 70 m.p.h., and is stable at speeds as low as 30 m.p.h. Landing is very easy, as the air brake allows a steep approach to be made. It is very stable except in bumpy air. It is not known whether this type will be suitable for planes carrying heavy loads, but theoretically there is no reason why it would not be.—*Engineering.*

THE TEST of an Engineering plan is its adaptability to the purpose for which it was designed.

Training for Institute work is an important engineering problem. The success of our many students after entering the Institute is due to their adaptability to Institute requirements and proves the thoroughness of our methods.

CHAUNCY HALL SCHOOL

554 Boylston Street, Boston, Mass.

FRANKLIN T. KURT, Principal

Why Tie Up Capital?

Is your capital working in your business or tied up in a fuel supply?

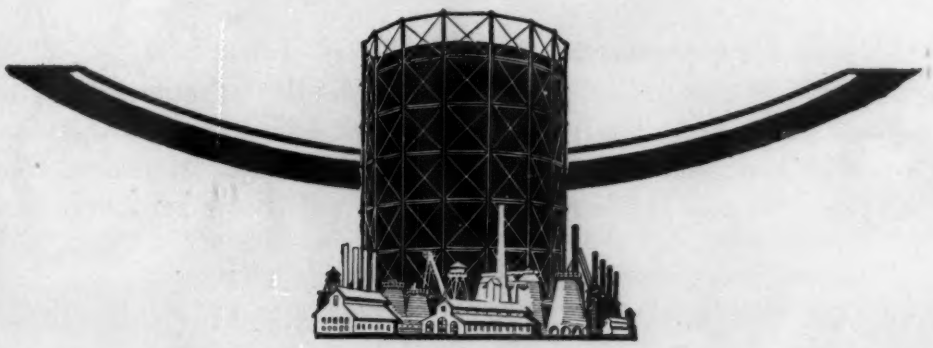
Your local gas company will supply fuel *as you need it.* You don't pay for gas till *after* it is used.

There are no tie-ups, or traffic delays in the delivery of gas—a dependable supply always available at the burner.

The manifold advantages and economies of gas as a factory fuel are explained in our new book, "Gas—The Ideal Factory Fuel".

Write for your copy today—no charge.

American Gas Association
342 Madison Avenue :: New York City



Four Advantages of Gas

Dependable— any time, any place, any quantity.

Controllable— exact temperatures, automatically controlled.

Economical— lowest final cost per unit of production.

Clean— comfortable factory working conditions.

YOU CAN DO IT BETTER WITH GAS

The History of Three-Color Photography. By E. J. Wall, American Photographic Publishing Co. Boston, 1925. 747 pp.

This volume, as the title would indicate, is truly a history of the theory and practice of color photography. For thirty years the author, with tireless energy, has collected the notes upon which the work is based. Apparently every important patent or published article which bears on the subject-matter has been tucked away somewhere within the more than seven hundred closely printed pages that comprise the work. Although the title mentions only three-color photography, there is much valuable information on two-color methods, particularly with reference to motion pictures in color. Certain topics, such as the Lippmann, Seebeck, and Bleach-out processes were necessarily omitted because of the size of the volume. It is to be hoped that a second volume may soon include these processes as well as a similar summary of photo-mechanical methods.

It is quite probable that the reader without some previous knowledge of color photography will find this book difficult. Much of the introductory material that would be necessary in a text-book has very properly been omitted from such a treatise as this. In fact, the omission enhances its value as a reference work for the more advanced reader. The style of the work is one which might well be followed by historians in other fields than color photography. The subject-matter is presented in such a way that the original investigators seem almost to have collaborated with the author in the preparation of the volume. The reader is then able to form his own unbiased conclusions in regard to the merit of each theory or process. Some may wish that the author had more often expressed his own opinion as a guide to those less familiar with the subject. In particular, it is to be regretted that the author did not abandon his impartial presentation in the first chapter which deals with the theory of color photography. Here the early ideas are presented in many cases by direct quotations, and thus false theories are allowed to remain as if believed in by the author, where a footnote would have given the reader the benefit of modern knowledge.

This volume should certainly be in the hands of all serious workers in color photography. As a reference work, there is no other at all like it in any language. It would be well if the would-be inventor of new methods of color photography could be induced to use this book as a compendium of previous patents and practices which could save him much time and effort if he would consult it.

PROF. A. C. HARDY.

WHAT A WHALE OF A DIFFERENCE

"How can he build 'em so cheap? Perhaps the brake drum is small and the band narrow, but that wouldn't make much difference." Slipstick artists!—get busy and check up on this. The Ford Motor Co. has increased the size of the Ford brake drum, which it is estimated will take 13,000 tons more cast iron and 10,000 tons more steel per year than heretofore. The larger gasoline tank will take 2000 tons per year additional and the change in running board and shield design will require 5000 tons more. The change to all-steel car bodies will add to the company's yearly requirement 38,000 tons. Now we understand why our Ford doesn't have four-wheel brakes.—*Iron Age*.

Mildew Prevention. Finally a satisfactory process for rendering cotton fabrics mildew proof and water-repellent has been perfected. This will mean the saving of millions of dollars' worth of tenting materials which are destroyed each year by various organisms.

The fabric is impregnated with salts from minerals which are commonly known as "rare earths." These salts are used in soluble forms and then insolubilized by various methods. Samples of fabrics so treated were kept in chambers where the temperature was approximately 70° F. and the humidity such that the cloth was damp. The cloth had been previously heavily inoculated with a culture of mould spores. After four months in the chamber, no evidence of mildew or mould growth was found on any of the samples. Samples not treated with these salts showed the presence of mildew within a few days after being inoculated.

The water repellency is obtained by precipitating an insoluble soap of the minerals in the fabric. An important feature is that once the cloth has been treated the repellent withstands any amount of laundering with ordinary soap or cleaning with gasoline. This is not true of fabrics treated with aluminum soap, which is the process most commonly used.—*Textile Age*.

The Massachusetts Institute of Technology

SUMMER SESSION

***Courses for Teachers*, JULY 6 TO AUGUST 3, 1926**

Progressive Methods of Teaching

Senior High School Mathematics, Junior High School Mathematics, General Science, High School Chemistry, High School Physics, Classroom Problems, General Bacteriology, General Biology, Health Education Methods, Health Records and Statistical Procedure, and Electron Theory.

Courses in Mechanic Arts

Foundry, *July 7 — July 15* **Pattern Making, *July 16 — July 23***

Machine Tool Work, *June 21 — July 23*

Entrance Subjects

Entrance subjects are offered during the Summer Session in Mathematics, Physics, Chemistry, English, French, and German. Passing grades in these subjects will be accepted in lieu of formal entrance examinations.

For Descriptive Literature and other Particulars Address The Registrar, Massachusetts Institute of Technology, Cambridge, Mass.

VITRIFIED
Brick
PAVEMENTS
OUTLAST THE BONDS

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, ENGINEERS BLDG., CLEVELAND, OHIO

An Open Letter to *John P. Senior*

Dear Senior:—

Your campus days are very nearly over but don't let anyone mislead you into thinking that the "gladdest years of life" have also passed. Tackle the job of living with a little gumption and you'll find each succeeding year more enjoyable and satisfying than the year that preceded it.

Your big job in the next few years is to set your standards and erect your reputation. What the world wants to know about you is the soundness of your judgment and the dependability of your performance. Don't take chances on those two points. A clean reputation for solidity, trustworthiness and dependable performance is the goal to aim for. (Your dollar-income at first probably won't total very much under the best of circumstances, so be sure your *reputation-income* is the biggest possible.)

Team up with the best in everything that you handle. Stand for, advocate, fight for the best materials, the best designs, the best construction methods. Don't let your name come to get associated with second-bests, makeshifts and could-have-been-better-with-a-little-more-work-and-thought.

Build your reputation now—your fortune will come later.

The world doesn't owe you a living but it's ready and willing to pay you handsomely when you have justified it. It's a great world once you have made it respect you.

I've seen a lot of it and I know.

Sincerely yours.

Vitrified Brick

Bacteria—the Smallest Workers

(*Continued from page 111*)

to even estimate the investment in canneries and refrigeration plants in the United States today, but the amount, however large, is a small figure compared with the damage bacteria would cause if food products were not treated in such a manner. The Pasteurization of milk, which is now carried on in every modern community, is but a heating process which kills bacteria, like those of typhoid fever and tuberculosis, which might cause disease if present. It also improves the keeping qualities of the milk, as milk becomes sour through the action of bacteria, and the smaller the number of organisms present the longer time will be required.

The fact that moisture is concerned in the growth of bacteria has been mentioned. As they require a certain amount of water for their own growth, it has been found that drying foods will cut bacterial action down to a negligible amount. Hence we have dried meats, fish, raisins, prunes, gelatin, dried eggs, and even dried milk. Each of these drying processes has resulted in the development of special industries, with different methods but a common goal, the preservation of goods against the inroads of bacteria.

All the industrial processes involving bacteria, whether they be designed to use bacteria or to prevent bacterial action, require the co-operation of other branches of science. Chemistry is a necessity for an understanding of the materials utilized by bacteria, and their changes in action are largely the result of their chemical environment. Engineering of all kinds is required to develop and operate the large canneries, the refrigeration plants, the highly developed dehydrating plants and operations similar to that used in the production of acetone and butyl alcohol. Each science plays its part, and is essential to the success of the task, when man undertakes to harness the powers of bacteria, the smallest workers in industry.

Engineers and contractors know that BUFF performance is accurate and sure—on all sorts of work, from running location lines to giving "neat lines" on important bridgework — without having to adjust the transit once.

Write for the BUFF Catalog No. 20M

Buff & Buff Mfg. Co.
Jamaica Plain, Mass.

BUFF
TRADE MARK TRADE MARK

TOADSTOOLS OR HARD-BOILED EGGS

We all know that toadstools, taken internally, have a bad effect. Now we are told that hard-boiled eggs, taken internally, may have the same bad effect — that is, if the subject is angry when he eats them.

Dr. Hilton Ira Jones, chemist and psychologist, says that the greater part of a hard-boiled egg is a chemical substance called colin. When a person is angered, the acidity of the stomach is increased to such an extent that the colin is oxidized into muscarine, and muscarine is the poison in toadstools. The effect, of course, is the same no matter whether the angry person eats hard-boiled eggs or toadstools.

Editorials

(*Continued from page 123*)

The proper guests of honor for such a function are the President and Faculty of the Institute. The proper spirit of this occasion should be one of democratic comradeship with an all-embracing spirit for the entire class.

A dance at the Copley-Plaza is a most delightful and desirable function for any who can and should attend it, but a dance at the Copley-Plaza has no place in any democratic scheme of things.

Back in the early days of the development of what is known as higher education, the Junior Prom and Senior Week had their beginnings. They were modest, simple, hearty. They promoted and distributed a broad class and institution feeling, but the high-priced function of today, which is an exotic bloom on what should be a healthy plant, has little place among the purposes of these earlier activities.

Nature herself erects enough walls. Human nature within that frame, and for perfectly good philosophical reasons, should devote most of its time to tearing walls down. Why we should pay high prices in money, energy, and moral character to create social conditions where we can be in contact with the superficialities and conditions under which there is no possible chance of our meeting or being with the people whom we really love and revere is an interesting social phenomenon which has momentarily influenced us to ask for the attention of the student body of the Institute.

The City. By R. E. Park and Others. Chicago: University of Chicago Press, 1925. 239 pp.

Unlike most of the literature on the modern city, which deals with municipal government and municipal services, this book goes deep into the traits and instincts of the human beings who make up the city. It attempts, by studying human behavior in a city environment, to discover the underlying causes of the city's social forces and social problems. At first glance, this seems a bit remote from the fields of activity of a Tech undergraduate; yet upon second thought, it will be seen that most of us are likely to become city dwellers and that an understanding of the hidden forces at work among the city's population can be of distinct advantage to us.

SAMSON SPOT SASH CORD

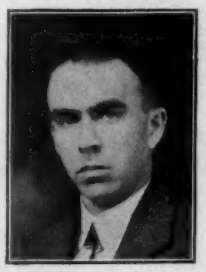
Trade-Mark Registered U. S. Patent Office

Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS -:- 88 Broad Street, Boston 9, Mass.

They call it the "Pierce Type"



R. T. PIERCE

When the class of '15 at Maine was being graduated, the name "Pierce" meant no more in the field of metering than Sweeney or Jones. Today, however, if you'll talk to such companies as the Detroit Edison Company, The Southern California Edison Company, the Duquesne Light Company, or the United Verde Copper Company, you'll learn that "Pierce" means a type of remote metering, which enables a man in a central dispatcher's office to read the condition of a sub-station several miles away.

Superpower brought in the need for an improved method of remote metering, and R. T. Pierce, Maine '15, in the employ of Westinghouse, devised it. He designed a system that operates on a new and different principle, and that has met with general acceptance in the Central Station field. He also was active in the recent re-designing of the entire Westinghouse instrument line.

It was only a few months after Pierce had completed the graduate student course at Westinghouse that he was given an assignment in the instrument section of the engineering department. He took it merely as a "fill-in" job. Soon he saw that instruments play a vital part in every electrical operation. As an instrument engineer, Pierce spent several weeks on the U. S. S. Tennessee and the Colorado during their trial runs. He has ridden in the cabs of electric locomotives. He is in closer touch with radio than anyone not a radio engineer.

A design engineer comes continuously in contact with sales negotiations, and Pierce's contact with them proved so beneficial that he was lately made head of the Instrument Section of the Sales Department, which means that he really has charge of the sale of all instruments to Westinghouse customers.

The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents? Or are they forced into narrow grooves?

This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company within the last ten years or so, after graduation.

Westinghouse

WESTINGHOUSE ELECTRIC

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers courses, each of four years' duration, in Civil, Mechanical, and Electrical Engineering; Naval Architecture and Marine Engineering; Mining Engineering and Metallurgy, and Geology; Architecture and Architectural Engineering; Chemistry, Chemical Engineering, and Electrochemical Engineering; Biology and Public Health, and Sanitary and Municipal Engineering; Physics, General Science, and General Engineering; and in Engineering Administration. These courses lead to the Degree of Bachelor of Science.

To be admitted to the first-year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfil entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German, and one elective subject. Examinations are required in all subjects except Chemistry, History, and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy, and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry, and Science have been established.

PUBLICATIONS

Bulletins of General Information, Courses of Study, Summer Session, Advanced Study and Research; and the Report of the President and the Treasurer.

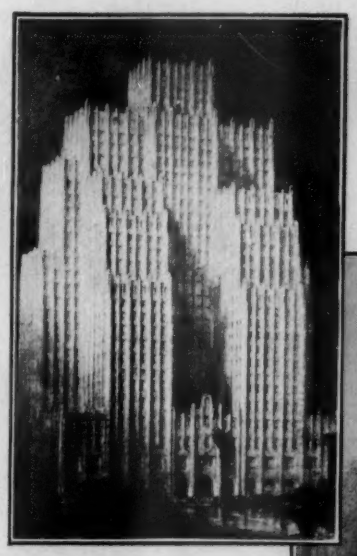
Any of the above-named publications will be mailed free on application.

For information, address

ADMISSIONS OFFICE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, MASS.

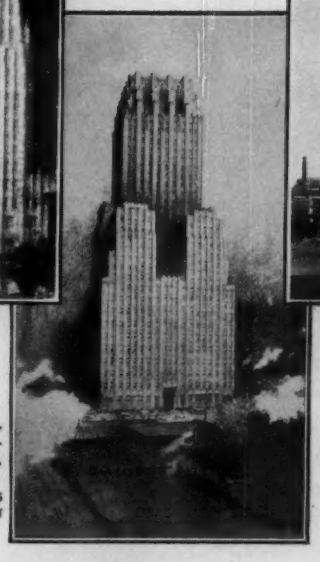
Push Button High Speed Transportation

Safer and Surer than Human Hands and Heads



Southwestern Bell Telephone Company, St. Louis, Mo.
Mauran, Russell & Crowell, *Architects*
I. R. Timlin, *Associate Architect*

Pacific Telephone & Telegraph Company, San Francisco, Cal.
J. R. Miller, T. L. Pflueger & A. A. Cantin, *Associate Architects*



Barclay-Vesey Building, New York Telephone Company, New York.
McKenzie, Voorhees & Gmelin, *Architects*

Ohio Bell Telephone Company, Cleveland, Ohio.
Hubbell & Benes Co., *Architects*

FOR many years, thinkers who watch mechanical progress with a friendly eye have asserted that the goal of machinery is to set mankind free from routine tasks, to give him time and opportunity for those tasks of the mind for which evolution has particularly fitted him.

In two of our most important industries there have been recent developments which may be truthfully said to have ushered in a new epoch. The dial telephone system, after years of experiment, has proved itself a practical and efficient servant of man. And the Otis Signal Control Elevator, also a product of untiring effort and experiment, marks a revolutionary step forward.

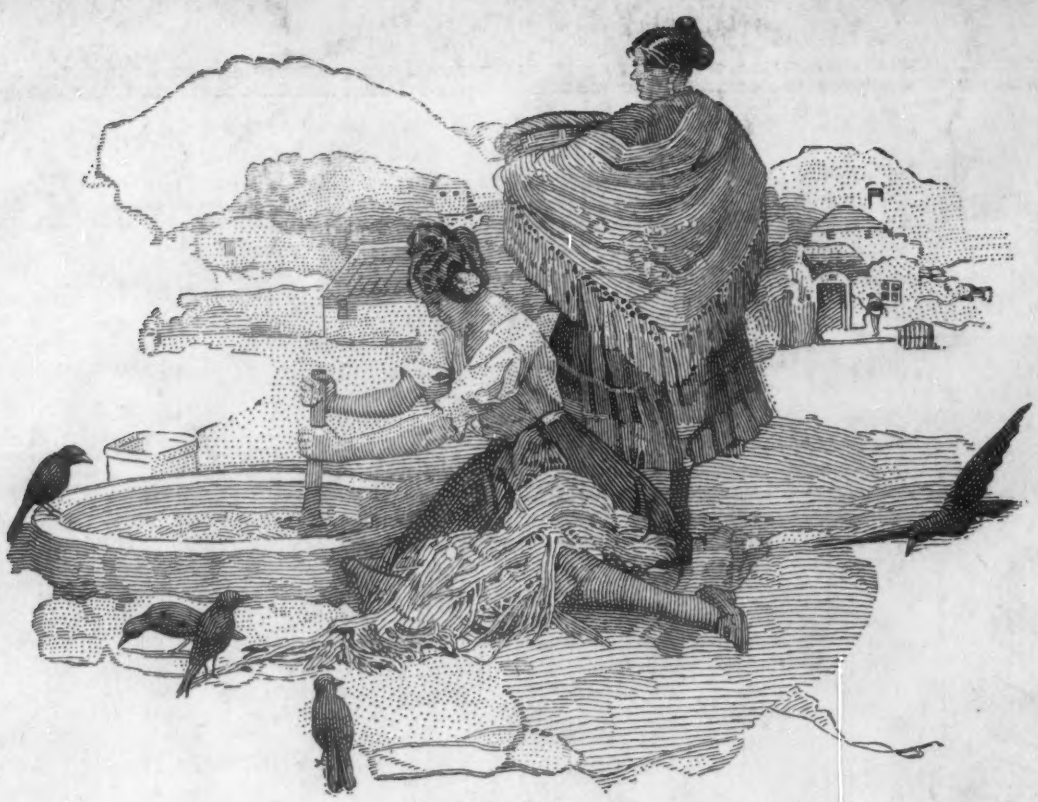
The transportation system of a modern building requires fewer elevators of this new type, than were heretofore required of other types. Control is entirely automatic, the car being operated by the pressing of car or hall button.

This type of control automatically brings the elevator to a stop within an exactness of level which eliminates the delays of readjustment experienced under the old system, and also automatically opens the doors as the car stops. This accuracy of landing greatly eliminates the possibility of accident.

In view of these epoch-making developments in the telephone and elevator industries, it is most appropriate that the four new monumental telephone buildings stretching across the country, and located in New York, Cleveland, St. Louis and San Francisco, should be equipped with the latest type of Otis Signal Control Elevators.

O T I S E L E V A T O R C O M P A N Y

Offices in all Principal Cities of the World



Crows

In a field in sunny Spain stands a stone mortar. Crows hover around it, picking up bits of grain and chaff—cawing.

Here Marcheta, in the fresh beauty of her youth, will come to pound maize. For years she will pound maize. The stone will stand up under the blows; not a dent has the muscle of three generations of women made upon it. But the crows will hurl their black gibes upon a woman aging early and bent with toil. *Old Marcheta*—still in her thirties.

The American woman does not pound maize. But she still beats carpet; she still pounds clothes; she still pumps water. She exhausts her strength in tasks which electricity can do better, and in half the time.

The high ideals of a community mean little where woman is still doomed to drudgery. But the miracles which electricity already has performed indicate but a fraction of the vast possibilities for better living and the tremendous opportunities which the future developments in electricity will hold for the college man and woman.

Electricity, which can release woman from her burdens, has already created a revolution in American industry. Wherever mankind labors, General Electric motors can be found carrying loads, driving machinery and saving time and labor. And there is no branch of electrical development today to which General Electric has not made important contributions.

A series of G-E advertisements showing what electricity is doing in many fields will be sent on request. Ask for booklet GEK-1.

7-72DH

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY. SCHENECTADY. NEW YORK